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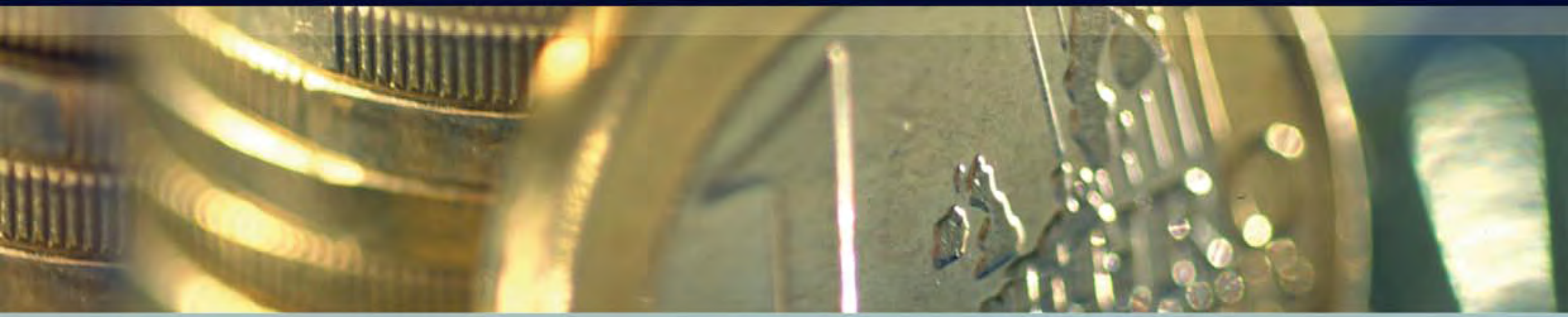

Market Integration and Technological Leadership in Europe

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Market Integration and Technological Leadership in Europe:

Mapping market share positions, product market diversification, multinationality, and technology scope and strength through the MSM methodology

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Executive Summary

Initially triggered by the Single Market Program launched in the late eighties of the past century, EU manufacturing industries have been characterized by major structural changes strongly affecting the market structure and competitive conditions of firms. The process of EU market integration continues to change the relevant markets on which firms compete, and forces firms to optimize their configuration of production activities and to build competitiveness based on innovation and technology development. In a more recent period the process of EU market integration has been associated with a stronger integration of the EU in the global economy, as witnessed by the growing openness of the EU to world trade and investment in the past decade. The latter globalization process has again stimulated firms to widen their production network and has provoked changes in the structure and scope of the operations of firms. The present study is the first to trace and analyse those changes in firm and industry structure by focusing on the interrelationships between production strengths, product diversification, multinationality, and technology strengths of leading firms in EU manufacturing industries.

The study builds on the methodology and results from a "EU Market Share Matrix (MSM) approach pioneered in prior studies. The MSM for the EU is a firm-level database covering production by location for all "leading firms" in EU manufacturing sectors. The EU market share matrix contains data on product **diversification** and geographical spread (**multinationality**) of the five leading firms in each of the manufacturing industries of the EU. Supplemented with industry data, the matrix data also generate the level of producer **concentration** for each industry. This study extends the MSM database for the year 2007 and, for the first time, adds a **technology** dimension to the analysis. The technology data include the leading firms' portfolio of patents in various technology fields and the location of inventions and allow estimating firms' **technological leadership** in sectors in which they are leading. The main focus of the analysis in the report is on the relationship between technological leadership and market leadership. Finally, the study explores how the MSM approach can be extended to the services sectors, through the presentation of case studies of ICT related services, telecom services, and the food retailing sector. Below we summarize the main findings of the study.

On *market leadership, diversification and multinationality*

- The 2007 matrix contains 250 firms, which together take up 305 leadership positions in 61 manufacturing sectors.

- There has been substantial change in the EU production leadership between 2000 and 2007 with on average 2 new leading firms per sector. Part of this turbulence in leadership positions is related to M&A activity. Turbulence is substantially smaller in high tech industries.
- Producer concentration (production share of the largest 5 firms in the EU) has further risen during 2000-2007 to 36 percent on average. This rise in concentration is to an important extent related to M&A activity and is accompanied by substantial turbulence in production leadership. Turbulence is lower in the industries with the highest concentration rates. The trend in concentration is not different for industries that were most sensitive to market integration in the EU.
- The global dimension of the matrix firms has increased. The presence of non-EU firms among the leaders increased to one third and new entry into the matrix is much more likely to come from non-EU firms than from EU-based firms. On average the leading firms have a growing global presence and within-EU spread of activities. The share of worldwide production of the leading firms that take place within the EU declined to 58 percent**.** Multinationality levels on average are equivalent to an equal spread over two world regions (global multinationality) and three EU countries (EU multinationality).
- Product diversification has further declined during 2000-2007 with diversification equivalent to an equal spread over two sectors on average.
- Incumbent MSM firms manage to maintain a significantly higher production share as compared to new MSM firms,
- Turbulence in leadership positions and new entry is more likely in low tech sectors and sectors with low producer concentration levels.

On *technological leadership, diversification and multinationality*:

- Out of the 250 MSM firms, 209 firms hold EPO patents in 2007 (84%). The Leading firms hold 31 percent of total EPO patents invented in the EU.
- On average, an MSM firm holds 2% of EU located patents of its MSM sector. This share has increased over time, suggesting an increasingly important role of technology for production leadership.
- In high-concentration sectors and high-tech sectors, MSM firms are found to hold the strongest technological leadership positions, and to have increased this position of technological dominance more than firms in other sectors
- EU based leading firms conduct a larger share of R&D in the EU than the share of the EU in their global manufacturing in the sector, but this ‘home bias’ in R&D is

however decreasing over time, especially in High-Tech sectors. Large technology firms have a smaller EU home bias compared to less patent active MSM firms. Non-EU based firms conduct a share of global R&D in Europe that is commensurate with their share of global production in the EU: hence, foreign firms' leadership positions are strongly associated with EU-based technological activities.

- Technology diversification on average is equivalent to an equal spread over 4 out of 30 main technology classes. Unlike product diversification, technology diversification is relatively stable over time. It is higher for firms in high-tech sectors and for non-EU based firms.

The MSM data and multivariate analysis provide strong support for a positive relationship between *technology and product market leadership*.

- Firms with a higher share of patents in their sector (a stronger EU technological leadership) have a significantly higher share of their sector's total EU production (a stronger EU product market leadership). This positive relationship remains highly significant and sizeable even when factoring in other sector or firm characteristics.
- Technological leadership is less important for incumbents to sustain their production leadership, as compared to new leading entrants. For new leading entrants, in contrast, technological leadership is very important to build up a sizeable production share. Although on average new leading entrants hold weaker technology positions compared to incumbents, this is not the case in high tech sectors. Those new leading entrants that do manage to build a strong technology position are rewarded for this in terms of higher production shares.
- In highly concentrated sectors, new leading firm entry is less likely to occur. Incumbency gives a greater advantage in terms of production share. Technological leadership in these sectors has no effect on production leadership for incumbents. For those firms that succeed in obtaining new leading positions, in contrast, technological leadership is very important for building a stronger production leadership.
- In sectors characterized by a higher sensitivity to the Single Market and/or by a higher technology intensity, technology positions are more important for production leadership, both for incumbents and entrants. This suggests that increased competition in the wake of single market reforms may have led to an increasing importance of R&D and innovation to maintain competitiveness.
- Firms that combine a strategy of product market focus with a broader technology portfolio can secure a stronger product leadership position.
- New entrants are broader in technology scope, suggesting that they leverage their technology position from other sectors to effectuate entry.

- In high tech sectors, and particularly for technology leading firms, there is an increasing trend of internationalization of R&D with firms locating R&D activities outside the EU. Among the leading firms, EU-based firms with a stronger global orientation in terms of the location of R&D achieve greater production dominance in the EU, indicating the possible importance and effectiveness of such global technology sourcing strategies for EU competitiveness.
- Incumbent leading firms that see their production share increasing over time are also more likely to increase their technology shares, confirming a positive link between technology and production leadership growth.

On *services sectors*

- While the ICT services sector is dominated by globally operating (US) firms, the EU telecommunication sector is dominated by EU firms, which derive most revenues from the EU and focus only on selected foreign markets and new member states in their expansion strategies. The technological activities of these firms show a similar focus on the EU.
- In both the ICT services and Telecommunication industries, the technology dimension and patent holdings are of increasing importance. In ICT there is a convergence with software firms increasing patent activities, while previous hardware firms (IBM, Sun) accompany a shift toward services with a reduced patent intensity. For the only EU based ICT service leader, SAP, a leading production position is related to the strongest increase in patent activity in the sector.
- In both ICT and telecommunication services there is an increasing concentration of patenting activity in core technologies, which are partly overlapping. Technological activities in the sector are mainly concentrated in the US. The EU is not an important location of US firms' R&D.
- In the food retailing and general merchandise retailing sector, there is a mix of moderately internationalized players from the EU and local EU players. EU retailers are relatively strong in the EU, in particular in their home markets. Patent data in this sector do not inform much about technological leadership.

Implications for EU policy

These findings suggest a number of *implications for EU policy*:

- Since technological strength and breadth are increasingly important for leading firms to build and sustain product market positions in the EU and this across all sectors, innovation policy instruments geared towards improving firms' technological strength and breadth, are rightly emphasized as an important component of the Lisbon Agenda for Growth and Jobs.

- Specific policy attention should be devoted to new leading firms. The analysis indicates that for firms to become a leader in the industry a broad, and especially a sufficiently deep technology portfolio in the targeted sector is important. This holds particularly for highly concentrated sectors. Consequently, barriers to build such broad and deep technology portfolios by firms should be eliminated as much as possible. As these barriers might be structural, as well as strategically erected, this involves, beyond innovation policy instruments, also competition policy instruments.
- As the results highlight the positive correlation between production leadership and technological leadership, but also point out the more difficult entry of new leading firms in highly concentrated sectors, technology considerations should be more on the radar screen of competition authorities, when analyzing competition cases in these sectors. Competition policy authorities should particularly keep a close eye on whether dominant incumbent firms use their market and/or technology power to pre-empt the building of broad and deep technology portfolios, which are important for entry by new leading firms.
- The location of inventive activities is highly correlated with the location of production activities both for EU and non-EU firms. Policies aimed at increasing the attractiveness of EU product markets, are therefore an integral part of a policy aimed at making the EU more attractive for R&D activities.
- EU firms that exploit global technological expertise are also the companies that manage to maintain the strongest production activities in the EU. Hence, the trend that EU firms are locating R&D activities outside the EU should not be seen as a trend to be reversed by policy.
- The fragmentation in the services sectors studied (particularly in Telecom and Retail, but less in ICT services), suggests that the Single Market Program should be further strengthened particularly in these sectors.

The analysis also brings out some important **limitations** of the MSM methodology and suggests directions for future extensions. The growing importance of offshoring and extra-EU imports in some sectors points at the necessity of analysis of EU *sales* leadership in addition to *production* leadership to uncover industry-wide competition effects and effective market dominance. For a further understanding of the relationship between product and technological leadership, the set of firms analyzed needs to be broadened to include firms that hold leading technology positions, but have no leading product market position. Finally, for a range of (low technology intensity) sectors, rather than patent based measures, alternative measures of innovation and technology would be preferable. Alternative technology indicators such as those from surveys on broader innovation activities do provide such alternative measures. Unfortunately linking EU-wide micro data from these surveys with other datasets faces many hurdles at present.

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0. Introduction

The process of market integration, initially triggered in the EU by the Single Market Program systematically changes the nature of competition, and therefore the structure of firms and industries. As in an integrated market more firms from different segmented markets compete directly in the bigger market place, lower prices for consumers are expected, together with increased efficiency and speedier innovation. In order to evaluate whether these anticipated effects are indeed materializing in the EU, various dimensions need to be traced. At the firm level, this includes the evolution in the average production size of firms, their multinational operations and diversification, and the size and scope of their innovative activities. At the market level, this includes assessing evolution in dominance in product and technology markets. This study proposes an integrated methodology, the "technology-extended MSM methodology", which allows tracing these various dimensions simultaneously.

This study builds further on results from a previously developed "EU Market Share Matrix (MSM)". The MSM for the EU is a firm-level database covering all "leading firms" in EU industry[1]. It has first been constructed for 1987 and again for 1993, 1997 and 2000 for all manufacturing sectors[2]. For each leading firm in a specific year, the matrix includes estimates of its total *EU production* together with estimates of production across the different Member States and outside the EU. It also includes estimates of production in different sectors. The EU market share matrix, although a very compact database (containing about 250 firms), is nevertheless capable of generating estimates of various key structural variables: sectoral diversification, geographic diversification (multinationality) at the firm level, and producer concentration within sectors.

In this project, we extend the MSM database in several ways. First, we update the market share matrix to the year 2007. This allows tracing the changes in structural variables over a longer and more recent time period. Second, we explore whether the MSM approach can be extended to the services sectors, through case studies of ICT related services, telecom services, and the food retailing sector. But most importantly, we extend the matrix with the technology dimension. To this end, we add for all MSM "leading firms" their portfolio of

[1] A firm enters the MSM as a "leading firm" in a particular year if it is one of the five largest EU producers in at least one EU manufacturing industry in that year. Any firm having production facilities in the EU qualifies to enter into the matrix, including non-EU firms.

[2] For a full report of the 1987 analysis and a detailed description of the principles and methodology we refer to Davies and Lyons (1996). For a thorough analysis of the MSM 93, 97 and 2000 see Veugelers et al. (2001). To make comparison over time possible, a 'time-comparable' matrix for all years was constructed, which allowed tracing key variables over time. For an analysis of these time-comparable data collections, we refer to Van Pelt et al. (2002).

patents in the various technologies in which they are active, and the location of inventors to these patents.

The main focus of this project will be on the relationship between technology and market leadership. Specifically, we examine the leading firms' technological leadership in the EU based on their portfolios of patents invented in the EU. The main research questions to be addressed are:

- How does technological leadership vary across sectors and evolve over time along a continuing process of market integration?
- How do technological leadership and product market leadership relate? Are product market leaders more likely to be technology leaders and vice versa?
- To what extent can a diversified technology portfolio contribute to maintaining product market leadership and building new product market (leadership) positions?
- What is the relationship between technology positions in the industry and turbulence in product market leadership, and to what extent are new entrants into leadership positions holding strong and/or broad technological positions?

The latter question is particularly important to assess the role of technology strategies in EU leading firms' capacity for structural change.

In this report we present our findings. The next section describes the conceptual background and reviews relevant prior literature on technology and market leadership. This is followed by a more detailed description of the research questions that the project seeks to answer (section 2). In section 3 we describe the methodology followed to arrive at the relevant indicators on the market and technology dimensions. Sections 4-8 describe the results of the exercise and analysis. Section 4 presents the results on market leadership in 2007 and compares this to leadership positions in the year 2000. Section 5 analyses long term trends in concentration, multinationality and diversification at the sector level from 1987 through 2007. Section 6 provides key findings on the technology dimensions, and describes technological leadership, technology diversification, and technology multinationality of the EU production leaders in 2007. Section 7 presents the results of detailed analysis of the relationship between technological leadership and market leadership at the firm level. Finally, section 8 presents the results of the three pilot studies for service sectors. The overall conclusions are presented in the final section 9.

1. Conceptual Background and Literature Review

In this review of the literature we first revisit the relationships between market integration, diversification and multinationality – the focus of prior MSM matrix analyses (1.1). We then review the literature on technological capabilities, technology diversification and R&D internationalization in section 1.2. In section 1.3 we review literature examining the interplay between technology strategies and market positioning. We conclude in section 1.4.

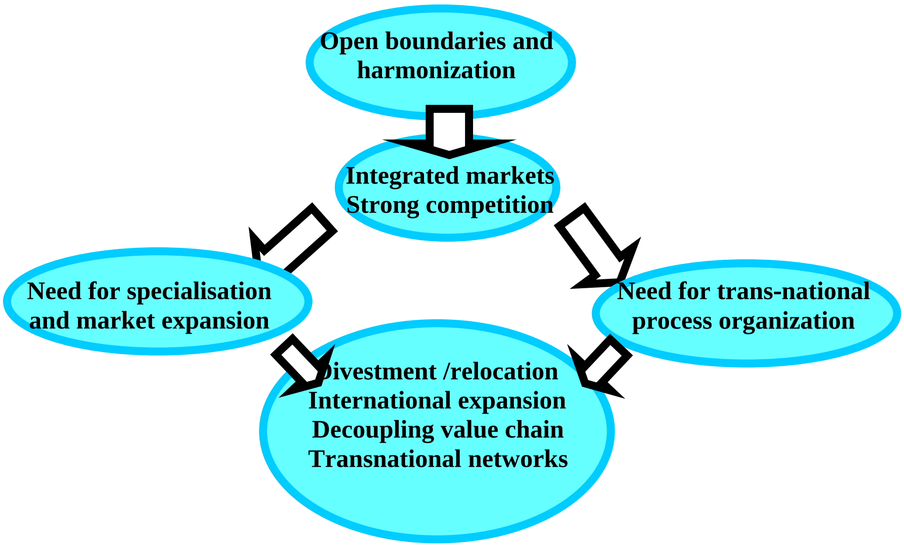
1.1. Market Integration, diversification, multinationality and market leadership

Market integration provides opportunities for an expansion of sales and production across national borders. It also poses several threats by increasing the level of competition from a diverse set of competitors based in different countries. The change in environment forces firms to re-evaluate their competitive position and to evolve in a structure where differences in factor costs across countries are exploited, and scale and scope economies are achieved in the most optimal manner (Van Pelt et al, 2002; Rondi and Vanoni, 20050; Davies et al, 2001a; 2001b).

There are several reasons why a more competitive environment forces firms to reconsider their product and geographical diversification. A firm that is facing more intense competition will feel the need to expand internationally, compensating for the lost market share in the domestic market and matching the competitor's positions in the other markets where they are present. In other words: the relevant market widens. However, a firm with high levels of product diversification will be challenged on various fronts and faces high resource and managerial constraints to successfully expand abroad in all the different activities. These constraints force firms to make clear strategic choices and concentrate resources on these products and services for which they can effectively develop a significant position in the wider relevant market. As a result, a trade-off emerges between product and geographical diversification of its activities (e.g. Davies et al, 2001b).

At the same time, in an increasingly global competition environment, international differences in factor costs push firms to reorganize their value chains and consolidate sub-activities of the value chain in these areas where conditions are best. This reconfiguration of the value chain may involve investments in overseas downstream or upstream operations, but it may also involve more flexible outsourcing agreements to foreign suppliers and OEM contractors. The need to concentrate resources on core-activities in particular, may drive firms to outsource these activities for which they find more efficient external parties. This and the development of an integrated market offers possibilities for logistics providers and other service providers to develop their own efficient networks across national borders, offering these services transnational at low cost. These patterns are depicted in Figure 1.1.

Figure 1.1: Market integration and the process of Transnational Restructuring



The effect of international market integration on corporate strategy and structure is receiving increasing attention in the empirical literature. Recent empirical studies for US firms found a negative correlation between competition from imports and the extent of firm diversification, and a positive relationship between competition from imports and geographic scope (Wiersema and Bowen, 2008; Bowen and Wiersema, 2005). In a related study Liu (2006) shows that US firms divest peripheral segments when their core segments are subject to import competition. Bernard, Jensen and Schott (2006) find this refocusing response to result mainly from imports from low-wage countries. Similarly, using case studies on Danish conglomerates, Meyer (2006) finds that firms focus on internationally competitive core businesses, divest peripheral businesses, and expand internationally as their home markets are opened to global competition. Hutschenreuter and Grone (2007) extend the analysis to competition by foreign firms through FDI. They argue that inward FDI as a high-commitment entry mode in the domestic market, is more threatening to the domestic market position, and hence invites more fundamental strategic responses by the domestic firms. In particular, they are likely to broaden their international operations in order to benefit from foreign locational advantages and capabilities, to ensure that they can compete on a more equal footing with the foreign challengers.

These results echo to a large extent the results found for leading EU firms in response to increasing market integration in the EU (Veugelers et al, 2001; Rondi, Sleuwaegen and Vannoni, 2003; Rondi and Vannoni, 2005, DeVoldere et al, 2004). These authors, using Market Share Matrix data, report a number of stylised trends. Over the period 1987-2000, the variation in level of geographical and industry diversification across firms decreased significantly, indicating a convergence in the corporate structure of matrix firms over time. Firm restructuring took place by divesting non-core activities and non-leading activities, thus supporting the ‘return to core’ thesis discussed in the literature. At the same time, the activities that were retained by firms after this restructuring process have been exploited on a larger international scale since 1987. This was not only the case for leading and core activities, but appears to be a general trend for all activities in which firms remained active.

The foregoing arguments have found support in the latest developments of the empirical literature analyzing industry adjustment to growing trade pressure. Several mechanisms have been identified. A first one works through firms' growth and strategy. For instance, Bernard et al. (2006b) show that the growth differential in favour of capital intensive firms rises with the level of import competition in US manufacturing. Moreover, affected firms are found to exit the industry, or change systematically their product mix in response to import pressure, shifting to more capital and skill intensive activities. Rondi, Sleuwaegen and Vannoni (2004), and Hutzschenreuter and Gröne (2009) for EU firms, and Bowen and Wiersema (2005)) for US firms, find firms to narrow their scope of product diversification in response to rising import competition. International outsourcing is found to be a strategic instrument sheltering manufacturing firms from import competition and raising the likelihood of their survival (Coucke and Sleuwaegen, 2008).

The increased focus on core business by leading EU firms reflects the need to obtain efficiencies from economies of scale while at the same time trying to minimize the problems of coordinating across multiple, and often unrelated, lines of business activity. As noted previously, such rationalization of activities is very similar to the response taken by US firms when faced with increasing international competition during the 1980s and early 1990s. However, unlike US firms, the initial restructuring by leading EU firms was driven largely by the *internal* opportunities and competitive pressures of internal market integration, not by the need to face, more broadly, global competition. In the period after 1995 when the EU became increasingly integrated in the world economy, the challenge shifted to respond to increasing *global* competition (see Bowen and Sleuwaegen, 2007). Similar to the way US firms reacted in the recent past, EU firms are responding by restructuring with a stronger focus on core activities and a growing emphasis on innovation. The surge in M&A over the recent periods 2000-2007 strongly reflects this motivation and, as shown later in the report, did have a deep impact on producer concentration in EU manufacturing industries.

1.2. Technology Strategies and Technological Capabilities

Technology[3] and innovation rank high on strategic agenda's of business firms as it allows them to create, sustain or advance competitive advantages. It adds superior qualities to companies' products and services, and lowers operating costs of business processes. In this section we review the literature on technological capabilities and technology strategies, including technological diversification and technology internationalization (international R&D).

Technological Capabilities and Market Performance

The primary conceptual and theoretical perspective on technological capabilities and market performance in the literature is the resource-based view of the firm (Wernerfelt, 1984; Barney, 1991; Teece *et al.*, 1997; Ahuja and Katila, 2004). The resource based view holds that resource heterogeneity is an important source of performance differentials among firms. Knowledge assets are seen as the major source of such resource heterogeneity (Kogut and Zander, 1996; Spender, 1996). A core premise of the knowledge-based view of the firm is that knowledge assets accumulated over time constitute the source of a firm's sustainable competitive advantage in the marketplace. Firm-specific knowledge assets are of strategic interest because they are rare, imperfectly tradable and hard to imitate as long as part of the technological know-how is not articulated or tacit in nature. The development of technology-related knowledge assets, "technological capital", is difficult, time consuming and expensive. Moreover, developing technological capabilities bares substantial risks given the large up-front R&D costs involved while the technological and commercial outcomes may be highly uncertain.

Because of the cumulative character of technology development, the current technological position of a company is shaped by its past technological activities (Teece *et al.*, 1997).

[3] Technology can be defined as those tools, devices and knowledge that mediate between inputs and outputs (process innovation) and that create new products and services (product innovation). It consists of equipment-embodied and person-embodied pieces of knowledge with a 'practical purpose link' (Rosenberg, 1972; Wang and von Tunzelmann, 2000).

Innovation can be defined as a cumulative process of incremental problem definition and solving activities (Rosenberg, 1982). As many problems are firm-specific, a firm's learning experience is distinctive. Due to the distinctiveness and cumulativeness of a firm's learning experience, its technological trajectory can be characterized as unique and path-dependent (Dosi, 1982; Garud and Karnoe, 2002). Consequently, firms' current technology portfolios are, at least partly, a reflection of their past problems, interests and capabilities.

The cumulative nature of technological capabilities has been confirmed in a range of empirical studies. For instance, Cantwell (2004) investigated in depth the technology portfolios of 4 large companies over a period of 100 years, and found that despite an enlargement of the initial technology portfolios over time, firms were after 100 years still technologically specialized in the technology fields in which they gained their initial competences. Hence, many firms follow a firm-specific, path-dependent technological trajectory (Breschi et al, 2003). At the same time, there is a high persistency over time in the composition of firms' technology portfolios which can be related to the nature of the innovation process that takes place within firms. In general, empirical studies confirm that, particularly in technology intensive sectors, a firm's success in technology development and innovation leads to firm growth while firms that underperform in innovation fall behind and risk being eliminated (Fagerberg, 2003; Baumol, 2003). Studies of firm market valuation (e.g. Hall et al. 2005; 2006) have shown that R&D expenditures and in particular a portfolio of (highly cited) patents increase economic performance. Patents, by giving firms the exclusive right to commercialize and appropriate the rewards of technology development can give firms the opportunity to increase profits on a more sustainable basis. Given the cumulative nature of technologies, with new inventions building further on prior inventions (Scotchmer, 2004), restricted access to prior patents in a domain will hinder new entrants to participate legally in technology development (Levin et al, 1987). Patent strategies may also be strategically used to hold potential entrants or rivals at bay. Patent fencing strategies – taking patents on many inventions in a technology field in order to turn parts of the technological landscape into a minefield of blocking patents – slow down new entrants or rivals from patenting in a domain and can hinder the creation of viable competitive positions by these firms (Granstrand, 1999).

While the arguments above suggest a positive correlation between innovation and sustainable profits, there is also evidence that translating innovation into success is not guaranteed. A number of factors may work to undermine the profitable position of large firms with established technology positions. A given technological base is not sufficient to guarantee longer term economic performance. This holds particularly in case of fundamental shifts in technological trajectories, such as the shift from chemical to biotechnology processes in the pharmaceutical industry, or the shift from analogue to digital technologies in the electronics industries. Large experienced firms aiming at the exploitation of their existing technology portfolios have configured their R&D resources and capabilities around the existing technologies and may be hampered in engaging in R&D activities that depart from their existing knowledge base (Leonard-Barton, 1992). In this sense, existing core capabilities can turn into core rigidities, which compromise the ability of the firm to adequately respond to forthcoming industrial and/or technological changes and thereby threaten the long-term survival of the firm (Leonard-Barton, 1992; Christensen & Overdorf, 2000; Tushman et al, 1997; Benner and Tushman, 2003).

Recent studies on long term stability in market positions in Japan (Kato and Honjo, 2000) seems to suggest that in the long run R&D and technology development can lead to greater turbulence in market shares rather than less turbulence. They find that market share persistence is weaker in R&D intensive industries, but greatest in capital intensive industries. The explanation is that technology development can provide entrants the possibility to leapfrog incumbents and attain market leadership, attacking entrenched positions. In mature low technology intensive industries, such shakeups rarely happen and scale economies related to stable markets can give incumbents a long term leading position. Similarly, Sutton (2007) finds that incremental changes in product characteristics are quickly mimicked by rivals and lead to stable market shares, while market shares change more rapidly in industries where firms introduce more difficult to replicate product innovations.

Technology diversification

Corporate diversification strategies have been widely studied in the literature. However, most of the diversification literature – grounded in industrial organization, financial economics and strategic management disciplines – has focused on the reasons and implications of product diversification (Chatterjee and Wernerfelt, 1991; Palich et al, 2000). Generally, the results in this literature stream indicate that related product diversifiers outperform both focused firms and unrelated diversifiers (Rumelt, 1974; Varadarajan and Ramanujam, 1987), and that refocusing has a positive effect on firm performance (Comment and Jarrell, 1995; Markides, 1995).

In more recent literature, diversification issues have been extended to the study of corporate technology diversification. The notion of technological diversification refers to the breadth of a firm’s technology portfolio, i.e. the number of technical disciplines a firm masters and innovates in (Breschi et al, 2003). Pioneering work in this domain has been done by Kodama (1992), Granstrand and colleagues (Granstrand and Sjölander, 1992; Oskarsson, 1993; Granstrand et al, 1997) and researchers at SPRU (Pavitt et al, 1989; Patel and Pavitt, 1997; von Tunzelmann, 1998). These studies have shown that large, technology-based firms have competences in a wide set of technology domains. Patel and Pavitt (1997) analyzed the patent activities of 440 of the world's largest firms across 34 technical fields, and found that only 4% of the sample firms were active in ten or fewer technical fields, whilst 52% were active between ten and 20 fields, and 44% in more than 20 fields, prompting the notion of *multi-technology* firms (Granstrand, 1998). Further, a large share of firms' patents were granted in non-core technology fields, for example 34% of patents of firms operating in electrical and electronics industries were granted in non-core fields such as chemical processes, plastics and non-electrical machinery.

Large firms build up and maintain diverse technology portfolios for three main sets of reasons. First, product and process complexity – i.e. the number of technologies embodied in products and processes – is high in most industries (Rycroft and Kash, 1999), making it necessary for companies to make, or buy, competences in a variety of technology fields. Therefore, the variety of firms' technologies tends to be larger than their product variety (Patel and Pavitt, 1997; Gambardella and Torrisi, 1998)[4]. Second, firms explore and experiment with new technologies in response to technological opportunities that emerge from general advances in science and technology. In this way, firms learn about the technical and commercial aspects of new technologies and assess their potential for future deployment (Granstrand et al, 1997). A third reason for technology diversification has to do with the efficiency of corporate R&D activities. Technology diversification may reduce the average costs of R&D because of economies of scope and knowledge spillovers across R&D projects. The specialized inputs needed in one research project, such as know-how and indivisible physical assets, cannot be easily traded on the market, while they can be shared with other research projects within the same firm (Henderson and Cockburn, 1996; Torrisi and Granstrand, 2004).

Hence, in the case of complex products and production processes, companies need to invest internally in complementary technology fields, even in the presence of technological outsourcing. The effective integration of externally acquired technologies requires an absorptive capacity in order to adopt and integrate the externally developed technologies. Moreover, Patel et al., (1997) argue that firms may want to develop some knowledge in non-

[4] Although technology and product diversification levels are not easily comparable because of different classification systems.

core technologies in order to have a window on emerging technological opportunities to an ‘internal’ exploitation justification, technological diversification also offers companies a further ‘external option’, i.e. the opportunity to license out their technologies to other firms (Cesaroni, 2004). Despite the presence of many problems surrounding the outsourcing of technologies, like the tacit character of many technologies, context specificity of technologies, licensing out technologies as a mean to capture value out of innovative activities has become more important during the 1990s. Mendonca (2002) further highlighted the important role of a general purpose technology like ICT in the trend towards technological diversification among large firms.

The drivers of technological diversification present themselves partly as industry-specific as demonstrated by Stephan (2002). He finds that pharmaceutical and telecom firms have technology portfolios which are on average considerably less diverse than those of firms within the automotive, electric engineering, chemical or material industries. Yet, considerable variance in technological diversification levels remains among firms within the same sector. This variance reflects the different bets made by management in the face of technological complexity and uncertainty (Nelson and Winter, 1977; Patel and Pavitt, 1997).

A number of studies have suggested that firm’s technological diversity has a positive impact on innovative performance. Diversification may increase cross-fertilization between different related technologies and may reduce the variance associated with the returns and therefore increasing the incentives to invest. Using R&D intensity and the number of patents as firm’s proxies of the degree of innovation and controlling for firm size, Garcia-Vega (2005) found a positive relationship. Breschi et al. (2003) confirmed that most of the patent applications worldwide are made by persistent diversified innovators. In a recent study, Leten et al (2007) suggest that a moderate degree of technological diversification increases innovative performance (as measured by patent applications) but that this impact is much larger if diversification is directed at technologically related domains.

Technology (R&D) Internationalization

It has long been considered typical for firms to concentrate corporate R&D activities in the parent firm’s home laboratory, making R&D the least internationalized business function. There are two main reasons why firms centralized R&D activities at home (Pearce, 1989; Patel and Pavitt, 1991). First, much technological knowledge is tacit and therefore ‘person embodied’ rather than ‘information embodied’. Physical proximity facilitates the transfer and integration of ‘person embodied’ pieces of knowledge. Economies of scale and scope in multidisciplinary R&D can be better accomplished via concentration of R&D activities. Patel and Pavitt (1991) analyzed patent activities of 686 large, R&D intensive manufacturing firms from different sectors and home countries, and found empirical evidence for the highly 'home biased' nature of corporate technological activities in the beginning of the 1980s.

Since the beginning of the 1990s this pattern has changed and firms increasingly internationalized their R&D activities (UNCTAD, 2005; OECD, 2008). While R&D internationalization is not a new phenomenon, it accelerated in the past decade and shifted its locational focus from triad countries (USA, Europe and Japan) to lower cost nations where skilled researchers are available in large quantities, including China and India. For example, the share of US firms' R&D sites located in the United States declined from 59 percent to 52 percent in the last decade, while the share of sites in China and India increased from 8 to 18 percent (Booz Allen Hamilton and INSEAD, 2006). UNCTAD (2005) reported that over half of all 1,773 greenfield R&D projects set up by companies based in developed nations between 2002-2004, were undertaken in developing countries.

The pace of R&D internationalization differs widely across nations. Empirical research (Granstrand, 1999a; Zander, 1999; Belderbos, 2001, Ambos, 2005) showed a sharp increase in international R&D activities of firms located in the US, UK and some smaller European countries. Japanese (and to some extent) German firms started later with the internationalization of their R&D activities, and do not achieve high internationalisation levels yet. Belderbos (2003) suggested that part of the explanation for the limited scale of foreign R&D operations of Japanese firms should be sought in the 'latecomer' status of Japanese firms in the internationalization of manufacturing operations.

A number of changes in the competitive, international and technological environment have driven increased R&D internationalization over the past two decades (Kuemmerle, 1997; OECD, 2007; Atkinson, 2007). First, developments in the codification and standardization of R&D processes have increased possibilities to segment R&D activities over different locations. Advances in information and communication technologies (email, internet, video teleconferencing) have further facilitated the management of globally distributed product development activities. Second, many nations have rapidly increased their science and engineering workforce, and improved the infrastructure and business climate to conduct foreign R&D. Based on international treaties like the TRIPS[5] agreement, patent right

[5] The TRIPS agreement (Trade-Related Aspects of Intellectual Property Rights) is an annex of the Marrakesh agreement establishing the World Trade Organization in 1994. It provides standards

systems have significantly improved in some countries, primarily less-developed countries that historically had weak patent systems, like China, India, Indonesia, and Turkey (Park and Wagh, 2002). Third, companies must move new products from development to market at an even more rapid pace. Consequently, firms build R&D networks that allow them to access geographically distributed technical and scientific expertise at lower costs. Fourth, technological and scientific expertise have become more widely distributed in the world, such that strong R&D clusters for particular technologies can co-exist in Europe, the US, and Japan. In addition, in countries such as China and India, rapid increases in R&D are combined with rapid growth in markets and income, making it much more attractive for foreign investors for in particular adaptive R&D.

There are two major motivations why firms conduct R&D outside their home countries (Florida, 1997; Kuemmerle, 1997). Traditionally, multinational firms set up foreign R&D activities to adapt and tailor home-developed products to local market conditions, and provide technical support to foreign manufacturing operations (‘home-base-exploiting’ or ‘market-driven’ foreign R&D). A second major motivation for foreign R&D is to harness geographically distributed scientific and technological capabilities and develop new technologies for world markets (‘home-base-augmenting’ or ‘technology-driven’ foreign R&D). Empirical studies have shown that both ‘home-base-exploiting’ and ‘home-base-augmenting’ factors play a role in attracting foreign R&D, with the latter gaining in importance in recent years.

Empirical studies have recently started to examine whether R&D internationalization contributes to the innovative ability and economic performance of multinational firms, and if so, under which conditions. There are several ways through which firms can benefit from globally distributed R&D activities in clusters of technical expertise. First, multi-location firms can absorb external local knowledge in foreign subsidiaries, and integrate this knowledge in the firm’s global organization (Belderbos, 2003). In order to tap into local knowledge sources, foreign subsidiaries need to become embedded in foreign research networks, and develop relationships with local economic actors (Griffith et al, 2006; Criscuolo and Autio, 2008). Second, having R&D personnel located in different locations avoids ‘group think’, increases exploratory learning, and the development of more unique and valuable competences (Zander, 1997). There may, however, be reasons why benefits from R&D internationalization do not materialize in practice (Singh, 2008): Having several small R&D units instead of one central R&D lab decreases economies of scale and scope, firms’ own

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concerning the availability, scope and use of intellectual property rights (including patents) for all signatory countries of the WTO agreement.

knowledge may leak away through foreign subsidiaries to local firms, and firms may face difficulties to coordinate and integrate globally distributed R&D teams. Empirical findings on the relationship between R&D internationalization and firm performance are not consistent across empirical studies. Some studies (Singh, 2008; Furman et al, in press) found negative effects, while other studies (Iwasa and Odagiri, 2004; Penner-Hahn and Shaver, 2005; Todo and Shimizutani, 2005; Criscuolo and Autio, 2008) found positive effects of R&D internationalization on firm performance. The positive effects in the latter group of studies were found to be conditional on local 'embeddedness' (Griffith et al, 2006; Criscuolo and Autio, 2008), the technological strengths of host countries (Iwasa and Odagiri, 2004), and a sufficient 'absorptive' capacity at the corporate headquarters to utilize foreign research findings (Penner-Hahn and Shaver, 2005).

Summarizing, the literature on R&D internationalisation suggests a number of relationships between market positioning and the geographic spread of technological activities: 1) a firm's multinational spread of production activities is positively related to international R&D activities 2) the persistent home bias in R&D may imply that non-EU firms perform relatively less technological activities in EU 3) R&D internationalization in recent years may be more responsive to global trends than to EU market integration 4) Technology sourcing R&D conducted by EU firms outside the EU may benefit their competitiveness in the EU.

1.3 Relationships between Technology Strategies and Market Positioning

In this paragraph we review the literature that examines specific aspects of the relationships between technology strategies and market positioning (diversification and multinationality).

Technology diversification, R&D, and Product Diversification

There is a two-way relationship between technology diversification and product diversification (Granstrand, 1998). On the one hand, diversified product portfolios provide more opportunities to appropriate results from diversified R&D activities (Nelson, 1959), and create a need for the development, or acquisition, of additional technical competences (product-driven technology diversification). On the other hand, the more diversified a firm's technology portfolio, the more companies are driven to realize economies of scale and scope through entering additional businesses (business-driven technology diversification).

Empirical studies by Silverman (1999) and Suzuki and Kodama (2004) have confirmed that corporate technological resources affect the choice of industries into which firms diversify. According to Granstrand (1998), the more technology and product portfolios are linked, the more there may be synergies. This pull-push pattern leads to the build up of technology-product couplings over time, e.g. the offering of products with a broad technology base and technologies that are applied in many products. First, there are static economies of scale which can be achieved when a certain technology can be used with minor adaptation costs in several different products, which is the case for generic technologies. Second, dynamic economies of scale can be realized by the learning processes that occur when technological knowledge is applied several times (Granstrand, 1998). Analyzing product and technology activities of 250 large industrial companies, Piscitello (2004) offered some evidence of a positive link between the 'interconnectedness of product and technology portfolios' and economic firm performance. Firms with diversified technology portfolios are however not always present in 'all' potential industries in which corporate technologies could be applied. Entering an industry also requires investments in downstream assets, which could be idiosyncratic to specific industries (Gambardella and Torrisi, 1998).

A related literature has focused on the consequences of business diversification on the R&D intensity of firms. Doi (1985) provides multiple reasons why diversified firms can engage in more R&D activity than less diversified firms. Diversified firms (1) are better able to access the massive financial resources needed for R&D undertakings; (2) can spread the risk of a failure of uncertain R&D programs over more products; (3) may achieve scale economies in R&D because of the involvement in technologically related fields, which may favour intensive R&D activity; (4) have many outlets for the uncertain new products and processes that may result from the R&D process (Cohen and Klepper, 1996). The pioneering studies of Grabowski (1968) and Scherer (1965) found a positive impact of the extent of business diversification on R&D expenditures. McEachern & Romeo (1978) and Doi (1985) distinguished between the impact of related and unrelated business diversification strategies and found mixed effects on R&D intensity. A possible explanation for these mixed findings is that the diversification of R&D activities is not taken into account (see section 1.2).

Technology Strategy and Multinationality

In general, the vast literature on multinational enterprises and foreign direct investment suggests that firms invest abroad to exploit their technological strengths (e.g. Caves, 1996) and studies have found a robust relationship between R&D and patent intensities and multinationality. Similarly, Kotabe et al. (2002) and Lu (2004) found a positive impact of technological strength on the performance of firms with internationally dispersed activities.

A limited number of studies have investigated the reverse or simultaneous relationship between the extent of international diversification (multinationality) and R&D investments. Economists have argued that firms producing innovations have a motivation to diversify geographically in order to achieve higher returns for their, often large, investments in R&D. At the same time international diversification can have a positive impact on R&D, as a greater geographic scope enables firms to spread R&D investment costs over greater sales. If international firms have access to a wide and diverse pool of resources (learning argument), this may increase domestic R&D productivity and help building innovative capabilities through R&D. Hitt A. et al. (1997) confirmed this positive impact of multinationality on R&D. However this impact was smaller if firms expanded abroad into unrelated businesses, i.e. if firms simultaneously expanded geographic and product scope.

Competition, technology, and innovation

A classical topic in the Schumpeterian tradition of innovation research has recently become the focus of a renewed research interest: the relationship between product-market competition and the incentives to innovate (Aghion, et al, 2005, Encaoua & Hollander, 2002, Knott & Posen, 2003). As Schumpeter posed the original question as to whether there are qualitative differences between the innovative activities of small, entrepreneurial enterprises compared to large modern corporations with own R&D laboratories (Schumpeter, 1942, Schumpeter, 1912), a number of researchers have taken up this issue, in particular, in the mid eighties, and tried to link these differences to various intensities of market competition. As a result, a variety of models emerged linking higher intensities of competition to decreasing (Dasgupta & Stiglitz, 1980) or increasing innovation (Reinganum, 1982) as well as characterizing some intermediate innovation outcomes (Spence, 1984). Empirical results did not contribute much to the debate in a way of resolving it. Most studies were unable to find residual effects of market structure when controlling for fixed effects related to industry characteristics (Scott, 1984) or utilized proxies for these characteristics (Levin, Cohen, & Mowery, 1985). In their survey of empirical studies on market structure and innovation in the 1980s, Cohen and Levinthal concluded:" Together these results leave little support for the view that industrial concentration is an independent, significant and important determinant of innovative behaviour and performance." (Cohen & Levin, 1989). It seemed that there was a belief among researchers that market structure and innovative behaviour were jointly determined by technological opportunity, the appropriability regime and market size. However, statistical tests based on cross-sectional data could not reject the hypothesis that market structure and R&D are jointly determined. Recent studies have taken up this issue and concluded that a mix of innovation and market structure variables need to be considered (Marsili & Verspagen, 2002) and that incentives and effects differ systematically between leading and lagging firms (Boone, 2000, Boone, 2001). This is in line with the idea the stable concentration rates may still hide substantial turbulence in market share and leaderships. Recent empirical work by Aghion and others has provided new evidence on the relationship between competition and innovation. Aghion et al. (2005) find an inverted U-shaped relationship between competition and innovation (R&D): but too little and too much competition can stifle innovative efforts. In particular competition discourages laggard firms from innovating as due to decreased returns, but it encourages neck-and-neck firms to innovate. Similarly, entry into industries by technologically advanced firms tends to increase innovative effects by incumbent firms, but in sectors where incumbents are relatively competitive and close to the technology frontier (Aghion et al, 2009). For EU industries, a recent empirical study by Griffith et al, 2008 suggests that on average reforms carried out under the EU Single Market Programme were associated with increased product market competition, as measured by a reduction in average profitability, and that this led to a subsequent increase in innovation intensity.

1.4 Conclusions

Overall the review of the literature suggest first of all that market integration, through an increase in competition, forces firms to 1) concentrate activities in sectors of strength, 2) expand abroad and exploit competitive advantage on a greater international scale, and 3) focus more on innovation to remain competitive. This may include overseas R&D activities and technology sourcing as a strategic response to strengthen future competitiveness. The stronger product focus associated with concentration on core business does not necessarily imply technology focus, as product development is increasingly relying on a wide set of technologies, and firms need competences in a wider set of technologies. A degree of (related) technology diversity increases innovation and market performance.

In general, it is clear that (technological) knowledge assets are crucial for sustaining competitive advantage. This is shown by the strong persistence in the types of technology portfolios and R&D activities in large firms and relates to the cumulative nature of technological learning. It is also shown by the regularity that innovative capabilities and patent holdings have an important impact on (expected) profits and market value. However, technology intensive industries tend to be characterized by greater turbulence in market shares in the long term. Such industries are characterized by greater uncertainty and potential technology/'paradigm' shifts (e.g. from analogue to digital technologies) and resulting opportunities for new firms to leapfrog incumbent leaders through more radical innovations. Incumbent large firms with their existing technology base and routines may be more inert and may be less able to react swiftly and succeed in development of new technologies, as compared to new firms. Contestable product markets are likely to invigorate such rivalry in innovation.

Although firms still concentrate a disproportional share of R&D in their home country, there is an increasing trend in internationalization of R&D. This reflects greater internationalization of production and need for product adaptation abroad, but also the increasing use of overseas technology sourcing strategies. Overseas R&D may actually be beneficial for home country productivity of multinational firms, if firms 'get their overseas R&D strategy right": they choose the right location, make sure that their R&D laboratory is locally integrated in R&D and academic networks, work on mechanisms to integrate knowledge flows within the firm cross-border, and they have sufficient absorptive capacity at home to learn from overseas R&D results. Furthermore, the increasing scale of multinational activities may also support greater overall R&D investments. While maintaining strong EU based manufacturing leaders is likely to lead to stable and large R&D activities in EU, at the same time, maintaining technology competitiveness will require EU firms to increase share of overseas R&D, and the difference in the EU located share of R&D is likely to converge between EU and non-EU firms in Europe over time.

2. Research Questions

While a number of regularities have evolved from the literature, few studies have investigated the complex interplay of technology, product and geographical diversification strategies and their relationship with technology and product market leadership. Moreover, the evidence on the main relationship of interest – between technological leadership and market leadership- is mixed. This brings us to a series of research questions that this project seeks to answer in the context of EU leading manufacturing firms.

The project provides an update and extension of the analysis that was previously performed on the MSM matrix data. This allows revisiting some research questions on the relationship between diversification, multinationality, and concentration addressed in previous MSM exercises. More importantly, the extension of the exercise with the technology dimension allows examining the relationship between product market leadership, multinationality and diversification on the one hand, and technology strategies on the other. This makes it possible to address an entirely new set of questions. These questions are listed below. They relate to four main themes, which further detail the 4 main research questions listed in the introduction.

1. Trends in Market leadership and Technological leadership

- Are the previously observed trends of consolidation of market positions, focusing on core sectors and increasing geographic spread, continued in the recent period, along a continuing process of market integration?
- Is the trend towards product and geographic restructuring, including lower levels of diversification and expanding geographical scope of production, also present in the patent portfolios of leading firms: i.e. do we see a trend towards concentration on core technologies and a greater geographical spread of technological activities?

2. Analyzing the relationship between Market leadership and Technological leadership

- Are EU market leaders also technology leaders? How many of the EU-MSM leaders are also technology leaders in the industry?
- Do firms that dominate product markets also control technology fields? Can firms that hold a strong position in key technologies translate this technological dominance into market dominance?

3. Analyzing the relationship between Market leadership and Technology diversification

- Is technology diversification necessary to be a market leader?
- Do MSM firms build up dominant market positions through specialized technology positions or through a diversified technology position: deep versus broad diversification?

4. Analyzing the Changes in market leadership and Technology positions

- Do new firms entering the MSM as leading producer in a sector do so on the basis of strong and/or broad technological positions?
- Are these technology positions in the same fields as the incumbent firms or in broader or more specialized fields?
- To what extent is technological leadership related to changes in product market leadership? Do concentrated technology positions in the industry correlate with reduced turbulence in product market leadership and market shares?

3. Methodology

3.1 Introduction

The project aims at analysing the data collected in a “EU Market Share Matrix” (MSM) which contains data of all the leading firms in EU manufacturing sectors. We use an industry classification based on NACE codes at the 2- and 3-digit level. This MSM industry classification has been used in prior MSM analyses (1987, 1993, 1997 and 2000). The level of disaggregation chosen is according to the relevance of markets. In several 2-digit industries (e.g. food, drinks and tobacco) industry leaders in one segment of the industry do not overlap with leaders in other segments. For these cases, it makes sense to perform analysis at the segment level (e.g. beer, spirits, pasta). In other cases, where similar industry leaders appear in similar segments, there is no need to conduct analysis at a more disaggregate level then the 2 digit level.

We construct the MSM matrix for manufacturing industries and in addition, as a test case, for a limited number of service industries: Telecommunication services, IT services, and Food Retailing. These service sectors have in common that services delivered are quite well delineated such that leading firms can be identified and the value of their activity in the sector determined.[6] The industries covered and the concordance between the MSM sectors and official NACE sectors is shown in Appendix 1.

For each of the sectors the industry top 5 is delineated by identifying the 5 firms with the largest EU *production* in this industry. A firm enters the matrix if it is one of the 5 largest producers in at least one EU manufacturing industry. Non- EU firms can enter the matrix, but only if they have production facilities in Europe. On the other hand, EU firms with leading *sales* in the industry may not be among the top 5 if they have (re-) located or outsourced their manufacturing activities outside the EU.

In the MSM exercise the total production of each leading firm is distributed both across industries (diversification) and across world regions (global multinationality) and EU countries (European multinationality). Those are the two dimension of the MSM matrix.

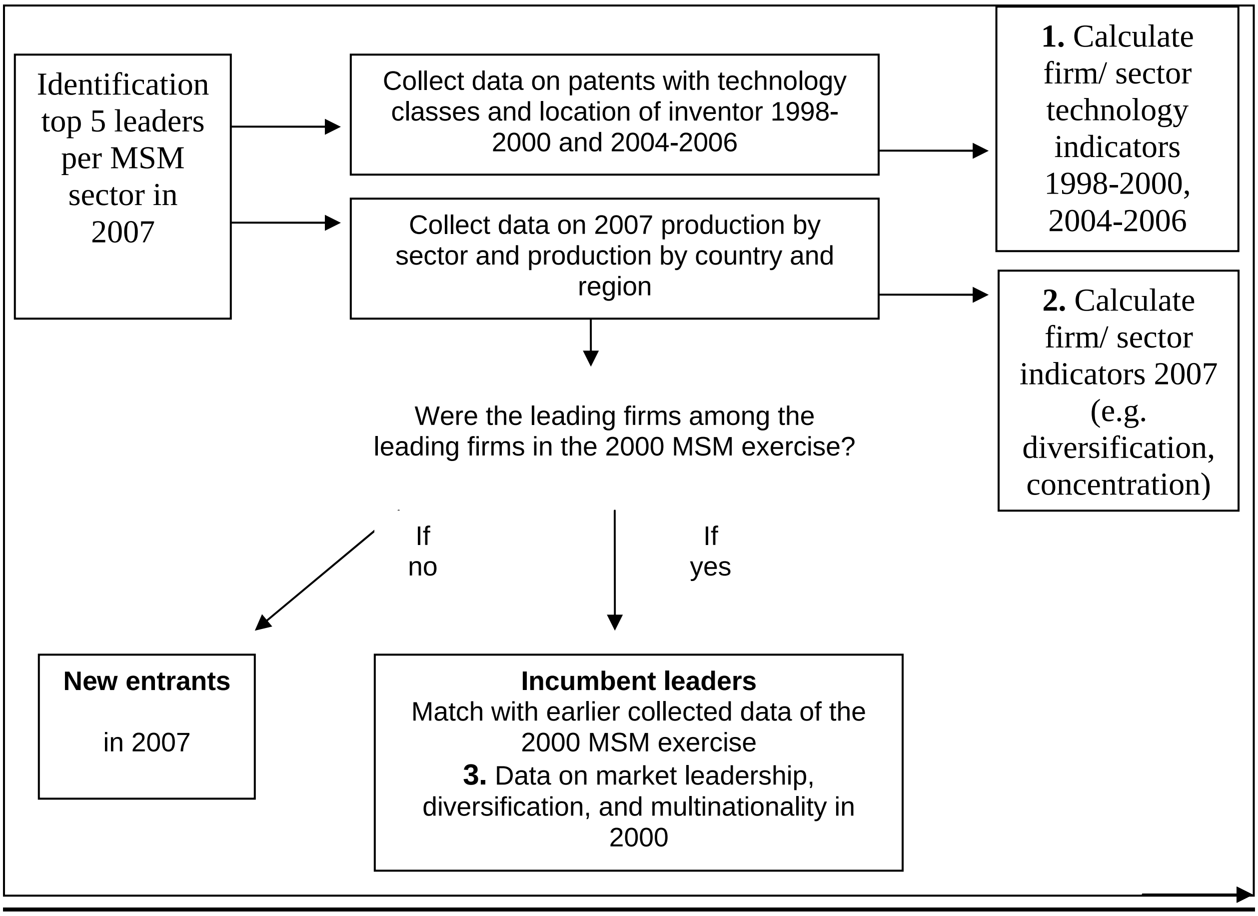
The last year for which the EU market share matrix exercise was conducted is 2000. In the current project, the matrix is constructed for the year 2007. New for the 2007 matrix exercise

[6] For the identified production leaders in the manufacturing sectors, the project also aims to identify their global service activities.

is that it is complemented with data on the technology domains and location of the leading firms' inventive activities, utilizing information from their patent applications at the European Patent Office (EPO). The patent data have the advantage that they are rich in detailed information and that a similar type of matrix structure can be derived in the technology dimension: diversification, multinationality, and technology concentration (see 3.3).

The structure of the data collection exercise can be depicted in the figure below. For all leaders in 2007 we collect their patent data in two periods, 1998-2000 en 2004-2006 (see section 3.3 for more information) and the production matrix information for 2007. For leaders that were incumbent in 2000 we can match the production matrix data in 2000, but not for the entrants in 2007. The leaders in 2000 that drop out of the matrix in 2007 (not in the Figure) are not part of the 2007 exercise; hence no patent data are collected.

Figure 3.1 Data collection Methods and Structure of the Dataset



While simple in structure, with the matrix data collected we can examine the following two generic types of questions, which are the basis for the research questions in section 2:

- For incumbents: analysing and relating market shares and growth therein to technology positions and changes therein
- For entrants, analysing the relationship between entry and their technology positions and changes therein

These questions can be addressed for the 61 manufacturing sectors in the Matrix. For the services sector in the pilot study no analysis of market share growth or entry can be conducted as these sectors were not analyzed in the 2000 MSM exercise. The services sectors will be covered in a separate case study in Section 8.

What we can ***not*** do for the manufacturing sectors is to fully depict the trend in technology positions (e.g. technology concentration or diversification), as we miss patent data of the 2000 incumbents that exited from the matrix. Similarly, we cannot analyse the role of technology in the exit of incumbents in 2000.

In the remainder of this section we describe the methodology followed to construct the MSM matrix in more detail: the Market Share Matrix Methodology in section 3.2, the technology dimension in 3.3.

3.2 Market Share Matrix Methodology

A number of steps have to be taken to arrive at the data necessary to construct the Market Share Matrix. First we identify the top 5 producers in the EU for each industry. In this exercise, we also collect the sales information for these major players, in the world and in the EU. Subsequently we estimate their production in the EU by location (and other major regions in the world) and their production diversification. Third, we calculate producers' shares by comparison with EU production data from Eurostat, and construct the various indicators at the sector level.

3.2.1 Identification of the top 5 leading firms

Before the matrix information can be calculated, it is necessary to identify for each sector the 5 leading firms in EU manufacturing. We do this by first identifying the 8 world leading companies active in the sector and by ranking these by consolidated sales, and subsequently estimated sales in the sector. This is a first set of firms from among which we investigate if it contains EU production leaders. We examine global leaders using the Worldscope database, which contains financial accounts information on the world's largest firms classified by industry. We also use lists such as Fortune or the UK Department of

Trade and Industry firm scoreboard. Based on Worldscope and the firms' annual reports we can usually determine the value of their EU sales on a consolidated basis and in the sector as a first indication of potential EU manufacturing leadership. In a subsequent step, we investigate whether these firms are manufacturing leaders in the EU. Here the main sources are the firms' annual reports and the Amadeus database, which contains financial information on all EU-incorporated firms required to submit financial statements. When using the Amadeus database, we make sure that we examine not only the parent firm in the EU, but also all the majority owned affiliates in the EU, while taking into account the line of business for each affiliate. Hence, we calculate EU leadership (and the other firm indicators) of the leading firms at the consolidated level, taking into account all affiliates and ownership relationships within the consolidated group. The Amadeus database contains information on such linkages but this is not always complete. Where necessary we make use of Dun and Bradstreet's Linkages database (Who owns Whom and annual reports of the firms).

Second, we use the results of the 2000 market share exercise as an input to investigate if leaders in 2000 are still EU leaders, based on their 2007 sales and manufacturing activities. We pay close attention to potential merger and acquisition activities in the past 7 years. For merger and acquisition activities, we can make use of the Zephyr database, which lists all European M&A activity in the last 20 years. This is a second group of firms from among which 2007 manufacturing leaders can be identified.

Finally, we analyze firms present in the Amadeus database by industry, which may lead to the identification of EU leading manufacturing firms that are not in the global sales top 8 or the 2000 top 5. This may occur in particular in industries in which the trend towards outsourcing and manufacturing relocation has been intensifying (e.g. consumer electronics, toys, textiles & clothing, sports goods), such that EU sales leaders are no longer EU manufacturing leaders.

The above steps allow identification of the top 5 leading producers in the EU (27). It is clear that in order to obtain this list of 5 firms, data search, data collection, and calculations have to be conducted for a much broader group of firms. In particular, information on EU sales (and often an estimate of production) has to be examined and assessed for a larger group of firms than the top-5. This information is stored for possible later use, but it is not part of the MSM database and MSM analysis.

3.2.2 Collection of data on multinationality and diversification

In the second step, we investigate the multinationality and diversification for each MSM top 5 firm. We distinguish these in terms of sales activity (sales by destination) and production (sales by origin). Data on firms' multinationality and diversification in terms of sales are noted in a MSM S-sheet. Data on multinationality and diversification in terms of production are recorded in the MSM P-sheet.

The following data are retrieved, calculated or estimated:

<u>Sales (MSM S-sheet)</u>

A) *EU Sales in MSM sector:* sales in the EU sector of leadership
B) *Global Multinational Sales.* Firms' (consolidated) sales per geographical region in the world. EU-27, rest of Europe, North America, Asia-Pacific (if possible, the share of China), and rest of world*;*
C) *Diversification:* Distribution of firms' sales over MSM sectors.

If information is available, the following information is also stored:

D) *EU multinational sales*: distribution of the firms' EU sales in the sector over EU27 countries;
E) *EU Sales Diversification:* distribution of firms' EU sales over MSM sectors:

<u>Production (MSM P-sheet):</u>

A. Value of EU production in the MSM sector;
B. *Global Multinational Production.* The distribution of the value of the firms production in the MSM sector by region of origin: the value of production in the different geographical regions*;*
C. *EU Multinational Production*. The distribution of EU production over EU countries
D. *Services Sales.* The value of services in firms' consolidated sales.
E. *Consolidated Global Multinational Production.* The distribution of the value of the firms' total production (consolidated sales – services sales) by region of origin: the value of production in the different geographical regions*;*

Where possible:

F. The distribution of the firm's services production over the geographical regions;
G. *EU Diversification:* Distribution of firms' EU production over MSM sectors:

This exercise involves retrieving a range of firm data in particular for the MSM P-sheet. It is necessary to check the Annual Reports of the companies, their websites and all other possible sources to determine how much these firms produce in EU countries. The data on production are not easy to find: companies tend to put more emphasis on sales in their annual reports rather than manufacturing and value added. There are several ways in which we can allocate sales by location of production (among EU countries and among world regions). Within sectors, we make sure that we use comparable allocation methods across firms. Procedures and particularities are listed below:

1. Using data on production volume (e.g. hectolitres of beer) of each branch/ affiliate of a firm as stated in the annual report;
2. Using other information from the annual report on the volumes produced and the presence and size of production affiliates in countries, such as sales, number of employees, and m² surface of facilities. Such lists can be found in the annual report or on the company website. It is important to underline that only subsidiaries with 50% or more ownership share are taken into account;
3. For (intra-)EU production calculation, using the Amadeus database, examining sales of the firm's affiliates in the EU that are engaged in manufacturing. Here the main issue to tackle is determining to what extent the activity of an Amadeus affiliate can really be regarded as manufacturing, or whether it's main activity is trade. The industry classification assigned in Amadeus is not always reliable. In such case, we can examine indicators such as value added (= sales – cost of goods sold) / sales; if this ratio is >30% manufacturing activity is likely. If information is completely lacking on the size of affiliate activity (Amadeus sometimes lists firms that barely report information), distribution over countries is based on the number of affiliates per country.
4. In cases where very little information is available (privately held firms), we attempt to retrieve further information by contacting the firm by telephone.

In a number of cases, the lowest positions in the top 5 are taken by minor producers that cannot be considered market leaders. This may happen in particular in industries where offshoring of manufacturing activities is common practice, such that EU niche producers have entered the top 5 of EU production leaders. Often, these are also privately held firms for which no published data are available, and which furthermore tend to refuse provision of information when contacted. These minor firms are identified and production is estimated, but no further indicators are developed in the context of the EU market and technological leadership analysis. In particular, a rule of thumb applies: if one of the top 5 producers in the EU records less than 20 percent of the production value of the firm ranked one position higher, this firm is not considered a market leader to be included in the complete MSM exercise. Such a pattern occurs for instance in the pasta sector, where the top 3-5 is taken by privately held niche and specialist producers with apparently small production volumes. In a few more cases, a complete lack of information on a privately held firm may also render it impossible to include the firm in the full MSM exercise. As a consequence, in a limited number of sectors covered by the MSM exercise there are fewer than five firms with a complete set of matrix data. Only for a subset of these firms (4 cases), it was not possible to obtain the value of EU production in the sector. Hence, the matrix has a near complete coverage of production leadership.

Comparison of the Sales and Production sheets will allow us to gain insight in outsourcing and relocation of production from the EU. Similarly, the comparison can show which EU based firms use EU manufacturing for an export strategy.

3.2.3: Indicators: Production and Market Shares, Diversification, and Multinationality

In a third step we determine production shares of the top 5 firms in the EU. We retrieve data from EUROSTAT on production value and exports and imports in NACE industries at the disaggregated level. We calculate industry value added, by aggregating up to the MSM industry level. This allows us to calculate for each firm its production share in the EU. Based on the information collected, we calculate a number of indicators at the firm and sector level. Defining subscript i for firm, subscript j for industry and k for member state, we have:

X_{ijk} = firm i's production in industry j in country or region k
X_{ij} = firm i's production in industry j
X_{ijEU} = firm i's production in the EU in industry j
S_{ijEU} = firm i's sales in the EU in industry j

$X_i = \sum_{j=1} X_{ij}$ = total global production of the firm (all industries, all countries)

Y_j = total EU production in industry j

Measures for Producer Concentration

C5 concentration in industry j is defined as the sum of the production shares of the five leading firms:

$$\textit{Concentration} = C5_j = \sum_{i=1}^{5} X_{ijEU} / Y_j$$ where i are the five leading firms in the industry.

Measures for Diversification

Diversification is defined as the spread of production over manufacturing sectors. We measure it by the number of equivalent of the Herfindahl index. Let N denote the number of manufacturing sectors (J=61 in the MSM matrix 2007). Product diversification is then defined at the consolidated level as:

$$\textit{Product diversification}_i = 1 / \sum_{j=1}^{J} \left(\frac{X_{ij}}{X_i}\right)^2 \text{ with J=61}$$

The definition is a transformation (the inverse) of the Herfindahl index. The Herfindahl index measures the degree of concentration of production among industries. It takes the value 1 if firms have production in a single industry only, and approaches zero if production is evenly dispersed over a large number of industries. This variable is a more accurate measurement of production diversification than a simple count of industries, since the latter is very sensitive to industries in which the firm has very little manufacturing. The Herfindahl is transformed taking the inverse. The index is usually termed the 'equal distribution number equivalent' of the Herfindahl index: the value represents the number of industries over which production would have to be equally distributed in order to generate the same value of the Herfindahl. In case of 61 industries, the minimum value is 1 and the theoretical maximum is 61. For example, if a firm has a manufacturing value of 100, which are equally spread among 10 MSM industries, the Herfindahl index is 0.1 and the diversification index is equal to 10. If however, among the 10 industries, manufacturing is largely concentrated in one or two classes, the level of diversification DIV is lower than 10. For instance, if two industries have a value of 30, and the remaining 8 each have 5, the Herfindahl index is 0.2 and the diversification index DIV is 5: this distribution of manufacturing leads to the same Herfindahl index as an equal distribution of the value of 100 over 5 classes.

The analyses in Section 7, will also make use of a directly related measure of '*product focus*' rather than product diversification: this is simply the Herfindahl index and measures the concentration of production.

$$\textit{product focus}_i = \sum_{j=1}^{J} \left(\frac{X_{ij}}{X_i}\right)^2$$

Measures for Multinationality

For multinationality we again take the number equivalent of the Herfindahl measure. The multinationality of a firm can be calculated at the global level (distribution over world regions) or at the EU level (European multinationality, distribution over EU countries) for the sector in which the firm is leading. Let n denote the number of countries or regions k, with n=27 in case of EU multinationality and n=5 in case of global multinationality across the five world regions. The global and EU multinationality indices are then calculated as follows:

$$\textit{global multinationality}_{ij} = 1/\sum_{k=1}^{5} \left(\frac{X_{ijk}}{X_{ij}}\right)^2$$

$$\textit{EU multinationality}_{ij} = 1/\sum_{k=1}^{27}\left(\frac{X_{ijk}}{X_{ijEU}}\right)^2$$

The global multinationality index has a maximum value of 5 (and a minimum of 1), the EU multinationality index ranges between 1-27. In addition, the analysis will make use of an indicator measuring the share of sectoral production of the firm that takes place within the EU.

$$\textit{EU share of sectoral production}_{ij} = X_{ijEU} / X_{ij}$$

Index of EU Offshoring

Based on the indicators for sales and production, we can calculate an indicator of the extent of offshoring (extra-EU) of EU production.

$$\textit{offshoring ratio}_{ij} = X_{ijEU} / S_{ijEU} .$$

The offshoring ratio is the ratio between production of the firm in the EU in a sector divided by EU sales of the firm in the sector. If this ratio is larger than 1, the firm uses the EU as an export base. If it is smaller than one, the firm relies on offshored production for its EU sales.

3.3 Technological Leadership Methodology

Technological leadership of the MSM leading firms, as well as the multinational spread of their technological activities, and the diversification of technological activities of the firms, is assessed through analysis of (consolidated) firm-level patent data. For each leading EU firm identified in the MSM exercise in 2007, we collect patent data at the consolidated parent firm level for the years 2000 and 2007. Based on the patent data, we can calculate the firms' EU technological leadership (number of patents relevant to the industry based on R&D conducted in the EU), technology diversification (distribution of patents over technologies), technology multinationality (distribution of patents over countries and regions of origin as seen from the location of the firms' inventors) and technology share (share of the firm's EU-originated patents in total EU-originated patents relevant to the industry).

3.3.1 Patent indicators

There are numerous advantages to the use of patent indicators as measures of firms' technological activities (Pavitt, 1985; Basberg, 1987; Griliches, 1990). Patents contain highly detailed information on the technological content, owners and inventors of patented inventions; they cover a broad range of technologies on which there are sometimes few other sources of data exist; patent information is 'objective' in the sense that it has been processed and validated by patent examiners; and patent data is easily available from patent offices and covers long time series. Like any indicator, patent indicators are also subject to a number of drawbacks: not all inventions are patented; patent propensities vary across industries and firms; and patented inventions differ in their technical and economic value (Mansfield, 1986; Levin et al, 1987; Arundel and Kabla, 1998).[7] Despite some shortcomings, there is simply no other indicator that provides the same level of detail of firms' technological activities as patents do (Griliches, 1990).

An alternative way to get information on firms' technological activities by technical field and location would be to survey firms. However, large firms are generally unwilling to disclose this type of sensitive information. Studies indicate that is a strong overlap between patent counts and other indicators of technological activities, such as R&D investments (Pakes and Griliches, 1984; Ahuja and Katila, 2001), expert rankings of companies' technological capabilities (Narin et al, 1987) and the number of new product announcements (Hagedoorn and Cloodt, 2003), qualifying patents as an appropriate indicator of firms' technological activities.

Patent indicators are calculated on data from the European Patent Office (EPO). We have chosen to work with EPO data instead of the more commonly used US Patent and Trademark Office (USPTO) data for two reasons. First, there exists a 'home bias' in patenting, meaning that firms are more likely to apply for patent protection in the patent office of the region where the inventions did originate (i.e. EPO for patents invented in Europe). Second, EPO patents are considered, on average, to be of higher quality than USPTO patents (Quillen and Webster, 2001; Van Pottelsberghe de la Potterie and François,

[7] In addition, part of patent application activity may be a more strategic nature, as patent 'fencing' of patent 'flooding' strategies can be used to slow-down new entrants from innovating in a domain by taking blocking patents on many inventions in a technology field (e.g. Granstrand, 1999).

2006). Due to long patent grant time lags at the European Patent Office[8], we opted for the use of patent application data as information source on firms' recent technological activities.

For each leading EU firm by 2007, we collect patent data at the consolidated parent firm level for the years 2000 and 2007. It takes between 18 and 30 months (depending on whether EPO patents are filed at WIPO or directly at EPO) before patent applications are published in the EPO patent databases. Given the most recent update of our EPO patent databases (mid 2008), complete patent data can only be collected at this moment for the years 2004 and only partly for 2005 and 2006. To compare technology positions between 2000 and 2007, we take two 3 year periods: 1998-2000 and 2004-2006. Aggregation over more years allows for a more precise depiction of geographic and technological diversification as well as technological leadership. We note that due to the 'truncated' nature of the patent data and the delays in patent publication, 2004-2006 patent numbers are biased downwards. Lower patent numbers in this period are no indication that patent intensities have fallen. Since the key indicators that we will use are relative indicators (patent shares, distribution over regions and sectors) the downward biased nature of the patent numbers should not be a problem for our analysis.

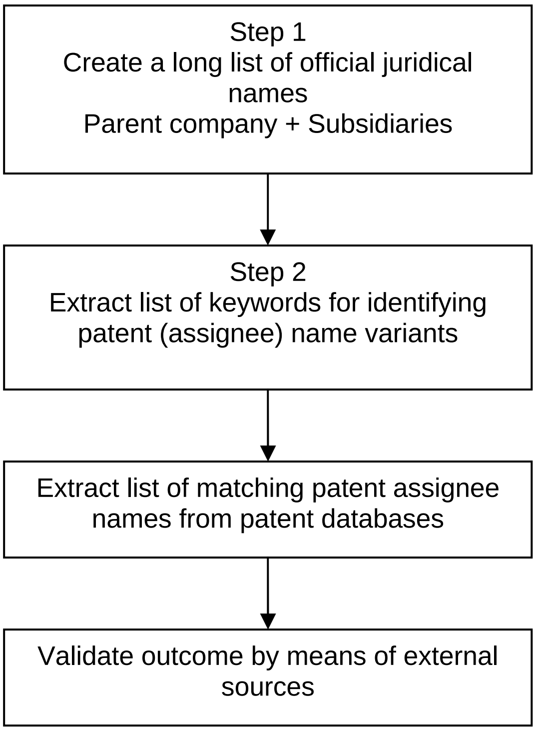
3.3.2 Consolidation of Patent Portfolios

Patent data needs to be gathered at the consolidated parent firm level because company names in patent databases are not unified[9] and patents may be applied for under names of subsidiaries and divisions of a parent firm. Therefore we search, for each parent firm, for patents under the names of the parent firm, as well as their majority-owned subsidiaries. Firm subsidiaries are identified via firm annual reports, yearly 10-K reports filed with the SEC in the US, and, for Japanese firms, information on foreign subsidiaries published by Toyo Keizai in the yearly 'Directories of Japanese Overseas Investments'. A consolidation is only representative for one year as the group structure of firms changes due to acquisitions, mergers, green-field investments and spin-offs, leading to changes in consolidated patent portfolios. Therefore the consolidation exercise is performed for each leading EU firm (anno 2007) for the years 2000 and 2007.

[8] For example, for EPO patents applied in 1995, the average granting lag is 5.01 years, with 25% of grants having a granting lag of 6 years or longer.
[9] For example, the German machinery company MAN appears under the abbreviated and full name in the EPO patent database, i.e. 'MAN' and 'Maschinenfabriken Augsburg Nürnberg').

For each firm, a stepwise approach is followed to collect the consolidated patent portfolios for the years 2000 and 2007.

Figure 3.2 Schematic overview of Stepwise Method for Consolidating Patent Portfolios



A first step consists of drawing up a *long list of official juridical names* under which parent firms might possibly have filed patents, including the name of the parent firm and all the majority-owned subsidiaries (for the years 2000 and 2007). The consolidated subsidiary list provided in audited Annual Reports, which can be accessed through different sources (e.g. company websites, SEC website, financial databases such as Amadeus, Dun & Bradstreet etc.), forms the basis of this long list. Remark that there exist differences in terms of completeness of the consolidated subsidiary lists given in annual reports, with some annual reports mentioning all their consolidated subsidiaries while others are only providing the names of the most important/first-level (not subsidiaries of subsidiaries) ones. Furthermore, the ownership percentages of the parent in the different subsidiaries, is not mentioned in all annual reports, implying a content analysis of secondary sources (company websites, press releases etc.) to search for this information.

This long list of names serves as the starting point for the second step, wherein *a list of keywords* is constructed. In order to find as many patent assignee name variants of the official juridical names as possible, it is important to create short keywords leaving out legal forms, country names, plural forms, non-significant characters and 'non-core' words (e.g. the Toyota subsidiary 'Daihatsu Autobody co. ltd' is represented by the keyword '*Daihatsu*', whereby the asterisk (*) symbol allows for characters before and behind the keyword).

In a third step, this list of keywords is used to search within a complete list of patent assignee names in the EPO patent database for relevant patent assignee names. The outcome of the query needs to be validated through a content analysis of secondary sources such as annual reports, company websites and web searches, what limits the potential for automation. This results in a *list of valid patent assignee names*.

Using consolidated patent data is important to get a complete picture of large firms' technological activities as a significant part of large firms' patents are not filed under the (current) parent firm name. It has been shown that close to 18% of parent firm patents are filed under the name of firm subsidiaries or name variants (e.g. old names) of the parent firms (Leten, 2008).

3.3.3 Firm Level Patent Indicators

Consolidated patent portfolios are used to create indicators of the technical strength and scope (technology fields/industries-of-use and countries) of the leading EU firms. Based on the retrieved and classified patent, we can construct a range of indicators that mimic the indicators on production diversification and multinationality. We calculate:

A) Firms' number of EPO patent applications;
B) *EU technological leadership /Share in EU sectoral patents)*: Firms' number of EPO patents in the sector, originating from the EU, expressed as a EU patent share (in comparison with the total number of patents originating in the EU27 in the sector);
C) Firms' share of patents originating in the EU *(EU patent share);*
D) *Global technology multinationality:* Firms' number of EPO patent applications distributed over geographical regions in the world – EU-27 countries (by country), North America, Japan, rest of Asia, rest of world – based on geographic origin of technology activities
E) *EU technology multinationality:* Firms' number of EPO patent applications distributed over EU-27 countries based on geographic origin of technology activities*;*
F) *Technology diversification:* Firms' number of EPO patent applications distributed over technology classes*;*

G) *Technology Fields*: Firms' number of technology classes in which it has patent applications.

Patents are assigned to their countries of origin (B) via address information of patent inventors. Inventor addresses are generally considered as more accurate indications of the geographic origin of large firms' patents than applicant addresses (Khan and Dernis, 2006). Large firms namely tend to use the address of the holding company or headquarters as applicant address, instead of the address of the subsidiary where the invention originated. If patents list multiple inventors based in more than one country, we assign the patent to multiple countries using weights based on the share of inventors from that country in total number of inventors of the patent.

Patents are assigned to technology classes (C) based on the full list of IPC (International Patent Classification) patent classes that are listed on the patent documents. These technology classes (minimum one) have been added by patent examiners and indicate the technical fields to which the technical objects of patents relate (OECD, 1994). A patent may contain several technical objects and can therefore be allocated to several technical classes. The IPC technology classification follows a tiered structure in which techniques are classified in sections, classes, subclasses, groups and subgroups. At the most detailed level, IPC contains 64,000 different categories, each represented by an alphanumerical symbol.

The IPC classification has been modified in different ways to produce other technological nomenclatures, such as the Fraunhofer-INPI-OST classification that classifies all IPC categories in 30 broader technology domains. This more aggregate classification has been most often used in research on technological diversification. Here patents are classified based on similarities in technology base. The spread of firms' patents over these technological classes provides a good indication of the technological diversification of firms. We will use the Fraunhofer-INPI-OST classification scheme in our analysis of technology classes.

3.3.4 Assignments of patents to sectors

In addition to Fraunhofer-INPI-OST technology classes, patents can also be classified by industry of origin. Patent shares of a firm in an ‘industry’ are the most accurate indicator of technological leadership relevant to the industry.

Because patents are classified according to the International Patent Classification (IPC) and based on technological categories, they cannot be directly translated into industrial sectors. In order to establish a link between technology classes and manufacturing industries (NACE, ISIC, etc.), various concordance tables have been developed. The concordance table used here is the one developed by Schmoch *et al.* (2003) from the Fraunhofer Institute for Systems and Innovation Research, the Observatoire des Sciences et des Techniques (OST) and the University of Sussex, Science and Policy Research Unit (SPRU). This concordance table is also used by OECD in their yearly publication on PCT patents.

The methodology used to develop this concordance involves four steps. First, a set of industrial sectors, defined by NACE and ISIC codes (2-digit level, with a finer breakdown of the quantitatively important sectors within chemicals, machinery and electrical equipment) was selected as a basis, leading to 44 sectors of manufacture. Second, technical experts from Fraunhofer ISI associated 4-digit IPC subclasses uniquely to industrial categories according to the manufacturing characteristics of products resulting in a first association matrix of technologies and industries. Third, the initial concordance table is refined by investigating patent activities by technology-based fields of more than 3 000 firms classified by industrial sector. This computation led to the elaboration of a transfer matrix or concordance between technology and industry classifications. Fourth, the adequacy and empirical power of the concordance was verified by comparing the country structures based on the concordance. In particular, this is done by comparing country level patent statistics – classified by industrial sectors – with the value-added and export structure of these countries.

Alternative concordance tables are developed by Verspagen et al (1994) and Johnson (2002). Both concordance tables link international patent classification codes (IPC) and economic sectors through a large set of probabilities (probability that a IPC code originates in a certain industry). These two concordances are considered to be less satisfactory than the concordance of Schmoch (2003) because they contain fewer industrial classes

(Verspagen, 1994) or are based on old data (Johnson, 2002). The Schmoch (2003) concordance is used most frequently nowadays (for example by OECD).

The assignments of patents to industries using the Schmoch (or other) concordance tables is for a number of sectors, particularly in low tech industries, not as disaggregate as the sector classification that we use in the MSM matrix exercise. For example, the Schmoch concordance contains one class for ‘food and beverages’ while this class encompasses 14 different MSM sectors. Furthermore the concordances provided by Schmoch (2003) are only available for manufacturing industries. In order to refine the concordance to make it applicable to the MSM matrix in cases where the Schmoch concordance provides less detail than the MSM industry structure, we examined the detailed IPC technology descriptions within a Schmoch industry to assess which 4 digit classes could be assigned exclusively to more disaggregate MSM sectors. In all MSM industries, a number of IPC classes could be uniquely assigned; another set of IPC classes within the broad Schmoch sector was assigned to multiple MSM disaggregate industries. Hence, we note that the allocation of patent fields to MSM sectors is not perfect, and in a number of cases too broad.

Using the extended concordance, we create a concordance table between IPC classes and 61 MSM sectors and we calculate the total number of EU originated patents for each of the 61 MSM sectors, as well as a unique EU originated patent total for each MSM leader in each of the MSM sectors. This allowed us to calculate EU technological leadership – the EU technology share of the firm in the industry. Annex 2 lists the Schmoch sectors that correspond to MSM sectors, and the IPC classes within Schmoch sectors that were allocated to multiple MSM sectors in case the MSM sectors are more disaggregate than the Schmoch sector. For further information on the Schmoch sectors we refer to Schmoch (2003)

3.3.5 Indicators

For the technology indices related to multinationality and diversification, we apply the number equivalent of the Herfindahl analogous as the multinationality and diversification measures described in section 3.1.3. We define:

T_{ij} = firm i’s patents in industry j
T_{if} = firm i’s patents in technology field f (Frauenhofer categories)
T_{ijEU} = firm i’s patents in the EU in industry j

$T_i = \sum_{j=1} T_{ij}$ = total patents of the firm (all industries, all countries)

Z_{jEU} = total EU patents in industry j

Z_{jWORLD} = total world patents in industry j

We can then present the expressions for the various indicators precisely:

EU Technological leadership $_{ij}$ (share of the firm in EU sectoral patents)= T_{ij} / Z_{jEU}

Worldwide technological leadership $_{ij}$ (share of the firm in worldwide sectoral patents) = T_i / Z_{jWORLD}

Technology diversification$_i$ = $1/\sum_{f=1}^{f} (\frac{T_{if}}{T_i})^2$ with f=30 (Frauenhofer fields)

The analyses in Section 7, will also make use of a measure of 'technology specialization', rather than technology diversification: this is simply the Herfindahl index and measures the concentration of technology activities:

Technology specialization$_i$ = $\sum_{f=1}^{f} (\frac{T_{if}}{T_i})^2$

We use three indices of internationalization of the consolidated technological activities, analogous to the indices of the internationalization of production. In addition to the two multinationality indices of the spread of technological (patent) activities over world regions and EU countries, as an additional indicator the share of technological activity taking place within the EU (patents of the firm based on inventive activity in the EU) is used.

Global technology multinationality$_i$ = $1/\sum_{k=1}^{5} (\frac{T_{ik}}{T_i})^2$, where k are 5 world regions

EU technology multinationality$_i$ =$1/\sum_{k=1}^{27} (\frac{X_{ik}}{X_{iEU}})^2$, where k are 27 EU countries

Share of EU in firm patents$_i$ = X_{iEU} / X_i

4. The Market Share Matrix in 2007

In this section we present key indicators of the 2007 market share matrix exercise. In section 4.1 we summarize the main indicators of the matrix. In section 4.2 we compare the production leaders in 2007 with those in 2000 and provide some statistics on market share turbulence.

4.1. Main Indicators of the Matrix in 2007

The 2007 matrix contains 250 individual firms leading in at least one of the 61 MSM-manufacturing sectors. This number is smaller than the 'maximum' number of leaders (61*5=305) because several leading firms are leaders in more MSM sectors.[10] Table 4.1 shows the distribution of firms by country of origin.

Table 4.1: Matrix firms by country or origin

EU Home country	# firms	Non-EU Home country	# firms
Germany	39	Switzerland	8
France	28	Iceland	1
UK	25	Liechtenstein	1
Italy	23	USA	40
Netherlands	12	Mexico	1
Sweden	10	Canada	2
Denmark	9	Japan	16
Finland	7	India	2
Austria	6	South Africa	1
Spain	5		72
Ireland	4		
Norway	4		
Belgium	2		
Luxembourg	2		
Portugal	1		
Poland	1		
EU- 27	178		

[10] For all but four firms identified as leaders in EU manufacturing, an estimate of EU manufacturing could be included in the matrix. Hence the coverage is near complete. For a group of smaller (often privately owned) firms, no further information on diversification and multinationality could be gathered. See also Section 3.1.2. Patent data, on the other hand, could be collected such that these smaller firms can enter the technology analyses in chapters 6 and 7.

Among the 250 firms, 178 are EU based and 72 non-EU based. Germany France, the UK, and Italy are home to the largest numbers of matrix firms. Among non-EU firms, 10 are based in Europe, 40 are based in the USA, and 16 are based in Japan.

Table 4.2 shows a number of key indicators of these matrix firms in 2007. Out of the 250 leaders, 140 were present in the EU leader matrix in 2000 and only 45 firms have been among the MSM leaders since 1987, indicating a fair degree of turbulence. More detail on sector-specific turbulence is provided in the section 4.2.

Average concentration in the industries is calculated as the share of identified MSM leading firms in total production of the sector (C5). The total sector production statistics are obtained from the Eurostat, ProdCom Statistics website. The average C5 concentration ratio in the MSM sectors is 0,36: the leading firms are responsible for on average 36 percent of production in the EU, which implies an average market share per firm of 7.2 percent. The overall coverage of the matrix firms in total EU production (weighted for the size of the sectors) is lower, at 28 percent, indicating that the C5 concentration ratios are higher in smaller sectors and lower in the larger sectors.

Table 4.2: Market share matrix 2007 Key Indicators

Number of firms	250
Firms also present in matrix 2000	140
Firms also present in matrix 1987	45
Non-EU firms	72
Matrix coverage	0,28
Average C5 concentration index	0,36
Average share of the firm in sectoral EU production	0,072
Average share of services in total sales*	0,07
Average diversification index*	1,81
Average EU share of firms' production	0,58
Average global multinationality index of production	2,12
Average EU multinationality index of production**	3,29
Average offshoring ratio	1,18

Notes; * calculated at the consolidated level; ** only available for a subset of firms

The diversification level of the matrix firm is indicated by the diversification index. This index shows that the average spread of consolidated production over MSM sectors is equivalent to an equal distribution of production over 1.81 sectors. This number is lower than the average diversification index of 2.20 reported in the 2000 Matrix, indicating that the trend towards specialization on core activities has continued. The share of services sales in total sales of the leading manufacturing firms is on average not larger than 7 percent.

The average share of the EU in global production of the firms is 58 percent. The global multinationality index on average is 2.12, indicating that the spread over the five global regions (EU, rest of Europe, Asia, North America, and Rest of the world) is equivalent to an equal distribution over two regions. This shows that the firms have important manufacturing activities across continents in most cases. Within the EU, the spread over EU-27 countries is equivalent to an equal distribution over 3,29 countries – indicating an important degree of multinationality within the EU.

The offshoring ratio is the production by MSM leading firms in the sector relative to the sales by these firms in the sector. It represents the extent to which EU production deviates from EU sales in the sector: A value larger than one implies that more is produced in the EU than is sold, indicating that the EU is an export base. A value smaller than one implies that MSM firms sell in EU markets more than they produce in these markets, indicating offshoring of production outside the EU. The average offshoring ratio is 1.18, indicating that on average the leading firms are using the EU as an export base.

More detailed information on concentration and offshoring per sector is provided in Annex 3. The numbers show as high-concentration sectors (with MSM leading firm shares in their sector of more than 50 percent) : clay, cement, soaps, pharmaceuticals, telecoms, tobacco, lighting, motor vehicles, aerospace, steel, clocks& watches, rubber & tyres and musical instruments. Further analysis of concentration will follow in section 5. Sectors were offshoring is an important phenomenon (i.e. where EU production represents less than 50% of EU sales) include TVs, sound & video recording, musical instruments, and furniture. In addition, in computer & office equipment the ratio is 55%. On the other extreme, sectors which are exporting extensively (i.e. where EU production represents more than 1.5 times EU sales) include aerospace, lighting and leather. We note that the degree of offshoring indicated by these numbers may still be underestimated at the sectoral level. This is because firms that are market leaders but have decided to offshore most of their production typically do not enter the matrix. The firms that are in the matrix necessarily will have a higher degree of concentration of production in the EU. This may apply to a number of sectors such as shoes & leather, and toys & sportswear.

4.2. The top 5 leading firms in 2007 and 2000

In this section we discuss the results of the first step of the methodology: the identification of the top 5 leading companies in each (manufacturing) sector. It also provides a comparison over time, between 2000 and 2007, thus giving a first impression of the turbulence in market leadership.

The tables below list the leaders in 2007 with their position in the year 2000. It also lists the leaders in 2000. Arrows indicate where leaders in 2007 were the result of mergers and acquisitions or if there was a name change of the leading firms, and details are specified in the notes column.

We report the sectors classified in 4 groups according to their technology intensity, following the criteria used by the OECD (OECD Science and Technology, 2001). Manufacturing industries are classified in four different categories of technological intensity. High-technology industries include: Aerospace, Office & computing equipment; Drugs & medicines, Radio, TV & communication equipment. Medium Technology groups the two classes distinguished by OECD: Medium-high-technology industries (Scientific instruments, Motor vehicles, Electrical machines excl. Communication equipment, Chemicals excl. drugs, Other transport, and Non-electrical machinery) and Medium-low-technology industries (Rubber & plastic products, Shipbuilding & repairing, Other manufacturing, Non-ferrous metals, Non-metallic mineral products, Metal products, Petroleum refineries & products, Ferrous metals). Low-technology industries are: Paper, products & printing; Textiles, apparel & leather; Food, beverages & tobacco and Wood industries.

In most high tech industries we see relatively little new leadership. In the aerospace and telecommunications sectors the leading firms are identical in 2000 and 2007. In the pharmaceutical sector, Aventis was acquired by Sanofi and Pfizer entered the matrix for Roche. In the computer sector, HP and Compaq merged, to create an extra space in the sector. IBM divested from the computer hardware sector and dropped out. The 2 places were taken by Canon and NEC.

Table 4.3: Top 5 per sector per technology category

High Tech Sectors

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
110 - Pharmaceuticals				
1 (4)	Novartis		Astrazeneca	
2 (3)	Sanofi-Aventis		GlaxoSmithKline	
3 (2)	GlaxoSmithKline		Aventis	Sanofi acquired Aventis
4 (--)	Pfizer		Novartis	
5 (1)	Astrazeneca		Roche	
115 - Computer and office equipment				
1 (1&5)	HP		HP	HP acquired Compaq
2 (--)	Canon		IBM	
3 (3)	Dell		Dell	
4 (4)	Fujitsu Siemens		Fujitsu-Siemens	
5 (--)	NEC		Compaq	
116 - Insulated wires and cables				
1 (4)	Schneider		Alcatel	
2 (--)	Hitachi		Pirelli	
3 (1)	Alcatel-Lucent		Corning	
4 (--)	Infineon		Schneider Electric	
5 (--)	General Cable		Draka	
120 - Telecom; television and radio transmitters				
1 (1)	Ericsson		Ericsson	
2 (2)	Nokia		Nokia	
3 (3)	Alcatel-Lucent		Alcatel	Lucent and Alcatel merge
4 (4)	Siemens		Siemens	
5 (5)	Motorola		Motorola	
121 - Television and radio receivers, sound or video recording apparatus				
1 (1)	Philips		Philips	
2 (--)	Sony		Bosch	
3 (--)	Panasonic		Grundig	
4 (4)	Harman International		Harman International	
5 (5)	Thomson		Thomson Multimedia	
130 - Aerospace				
1 (1)	EADS		EADS	
2 (5)	Finmeccanica		BAE systems	
3 (4)	Safran Group		Rolls-Royce	in 2005 the Snecma group, which included Snecmamerged with SAGEM to form SAFRAN
4 (2)	BAE Systems		Snecma	
5 (3)	Rolls Royce		Finmeccanica	

Medium-high Tech Sectors

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
108 - Chemical Products				
1 (1)	BASF		BASF	
2 (--)	INEOS		Bayer	Ineos expandes through a series of acquisitions (EVC, ICI assets)
3 (2)	Bayer		BPAmoco	
4 (--)	Dow Chemicals		E.on	E.On = now energy services supplier
5 (--)	Air Liquide		Royal Dutch Petroleum	Shell divests some chemical assets
109 - Paint and Ink				
1 (2)	Akzo Nobel		BASF	
2 (--)	SigmaKalon Group BV		Akzo Nobel	
3 (1)	BASF		E.On	E.On = now energy services supplier
4 (4)	PPG		PPG Industries	
5 (5)	ICI		ICI	
111 - Soap, detergents and toiletries				
1 (1)	Unilever		Unilever	
2 (2)	Procter & Gamble		Procter & Gamble	
3 (3)	L'Oreal		L'Oreal	
4 (4)	Henkel		Henkel	
5 (--)	Beiersdorf		Colgate-Palmolive	
113 - Manufacture of tractors and agricultural machinery				
1 (1)	Fiat Group		Fiat Group	
2 (2)	John Deere		John Deere	
3 (3&5)	Agco		Agco	The agriculural machinery part of Kone - Partek - was sold to AGCO
4 (4)	Claas Group		Claas Group	
5 (--)	Same Deutz Fahr		Partek	
114 - Manufacture of machine tools				
1 (2)	Bosch		Electrolux	
2 (--)	Hilti		Bosch	
3 (--)	Husqvarna		Thyssenkrupp	
4 (--)	Gildemeister		Saint-Gobain	
5 (--)	Charter plc		Air Liquide	
117 - Manufacture of electrical machinery				
1 (4)	Schneider		ABB	
2 (1)	ABB		Siemens	
3 (3)	Alstom		Alstom	
4 (2)	Siemens		Schneider Electric	
5 (--)	Johnson Controls		General Electric	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
118 - Batteries and accumulators				
1 (--)	Saft		Siemens	
2 (--)	Exide Technologies		Valeo	Valeo is more manufacturer of motor vehicles parts
3 (--)	EnerSys		Bosch	
4 (--)	Johnson Controls		Gillette	P&G acquired Gilette (with Duracell)
5 (4)	Procter&Gamble		Varta	
119 - Electronic valves, tubes and other components				
1 (1)	STMicroelectronics		STMicroelectronics	
2 (2)	Epcos		Siemens	Epcos is spinoff of Siemens and joint venture with Matsushita
3 (3)	NXP Semiconductors		Philips	NXP is spinoff of semiconductor division Philips
4 (--)	Avnet		Motorola	
5 (2)	Infineon	v	Texas Instruments	Infineon is spinoff of memory chip business Siemens
122 - Measuring, checking and testing instruments				
1 (3)	Bosch		Thales	
2 (1)	Thales		ABB	
3 (--)	Danaher		Bosh	
4 (4)	BAE Systems		BAE Systems	
5 (--)	Carl Zeiss		Siemens	
123 - Domestic electric appliances				
1 (5)	Philips		Electrolux	
2 (3)	Whirlpool		BSH	
3 (2)	BSH		Whirlpool	
4 (1)	AB Electrolux		Miele	
5 (--)	Indesit		Philips	
124 - Lighting equipment and lamps				
1 (2)	Philips		Siemens	
2 (4)	General Electrics		Philips	
3 (1)	Siemens		Zumtobel	
4 (3)	Zumtobel		General Electric	
5 (--)	Havells India		SLI	
125 - Motor vehicles				
1 (2)	Volkswagen AG		DaimlerChrysler	
2 (4)	PSA		Volkswagen	
3 (1)	Daimler		Ford	
4 (3)	Ford		PSA Peugeot Citroën	
5 (--)	BMW		Renault	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
126 - Motor vehicles parts				
1 (--)	Bosch		Faurecia	
2 (--)	Johnson Controls		Volkswagen	
3 (--)	Magna International		TRW	
4 (--)	ZF Friedrichshafen		General Motors	
5 (1)	Faurecia		Continental	
127 - Shipbuilding				
1 (3)	BAE Systems		IRI	IRI closed, Fincantieri was part of IRI group
2 (4)	AKER Yards		Alstom	
3 (--)	DCNS		BAE systems	
4 (1)	Fincantieri		Kvaerner	Aker Yards (2004) combining the shipbuilding activities of Aker and Kvaerner
5 (5)	Thyssenkrupp		Thyssenkrupp	
128 - Railway, locomotives and stock				
1 (3)	Alstom		DaimlerChrysler	DaimlerChrysler Rail Systems was sold to Bombardier in 2000
2 (1&4)	Bombardier		Siemens	
3 (5)	Finmeccanica		Alstom	
4 (2)	Siemens		Bombardier	
5 (--)	CAF		Finmeccanica	
129 - Cycles and motor cycles				
1 (1)	BMW		BMW	
2 (2&4)	Piaggio Group		Piaggio	Aprilia was acquired by Piaggio
3 (3)	Yamaha Motor Corporation		Yamaha Motor	
4 (--)	Honda		Aprilia	
5 (--)	KTM		Ducati	
131 - Medical instruments				
1 (1)	Siemens		Siemens	
2 (--)	3M		General Electric	
3 (4&5)	Philips		B. Braun	
4 (--)	Abbott Laboratories		Philips	
5 (--)	Fresenius		Marconi	Marconi was acquired by Philips
132 - Optical instruments				
1 (2)	Carl Zeiss		Kodak	
2(1)	Eastman Kodak		Carl Zeiss Stiftung	
3 (--)	Olympus		Alcatel	
4 (--)	Luxottica		Essilor	
5 (--)	Nikon		Agfa	
133 - Clocks and watches				
1 (2)	Swatch		LVMH	
2 (1)	LVMH		Swatch	
3 (--)	Movado Group		Richemont	
4 (3)	Comp. Financière Richemont		Artime	
5 (--)	Audemars Piguet		Gucci	

Medium-low tech sectors

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
		101 - Manufacture and first processing of steel + steel tubes		
1 (2&4)	Arcelor Mittal		Corus	Tata Steel Group acquired Corus
2 (3)	ThyssenKrupp		Usinor	Arbed and Usinor merged and created Arcelor which then merged with Mittal to create Arcelor Mittal.
3 (1)	Tata Steel Group		ThyssenKrupp	
4 (5)	Riva Group		Arbed	
5 (--)	Wurth		RivaGroup	
		102 - Non- ferrous metals		
1 (4)	Norddeutsche Affinerie AG		Johnson Matthey	
2 (--)	KGHM		E.On	E.On = now energy services supplier
3 (3)	Johnson Matthey PLC		Pechiney	
4 (4)	Umicore		Union Minière	Union Miniere changed name into Umicore
5 (--)	Norsk Hydro		Preussag	
		103 - Clay products		
1 (3)	CRH		Lafarge	Lafarge sold its roofing activities to PAI partners, who then sold them to Monier
2 (--)	Holcim		Wienerberger	
3 (2)	Wienerberger		CRH	
4 (--)	Monier		Saint-Gobain	
5 (--)	Terreal		Hanson	Hanson is now part of Heidelberg Cement
		104 - Cement, lime and plaster		
1 (--)	CEMEX		Heidelberger Zement	Heidelberger Zement renamed Heidelberg Cement
2 (3+5)	Lafarge		Italmobiliare	
3 (--)	Italcementi		Lafarge	
4 (1&4)	Heidelberg Cement		Hanson	Hanson is now part of Heidelberg Cement
5 (--)	Buzzi Unicem		Blue Circle Industries	Blue Circle was acquired by Lafarge
		105 - Articles of concrete, plaster and cement		
1 (1)	CEMEX		RMC group	RMC group was acquired by Cemex
2 (2)	Lafarge		Lafarge	
3 (--)	Saint Gobain		CRH	
4 (--)	Italcementi		HeidelbergerZement	
5 (5)	Buzzi Unicem		Dyckerhoff	Buzzi Unicem is now the majority shareholder of Dyckerhoff
		106 - Glass		
1 (2)	Nippon Sheet Glass		Saint-Gobain	
2 (5)	Owens Illinois		Pilkington	Nippon Sheet Glass acquired Pilkington
3 (1)	Saint Gobain		Asahi Glass Company	
4 (3)	Asahi Glass Company (AGC)		Carl Zeiss Stiftung	
5 (--)	Ardagh Glass Group		BSN glasspack	Owens Illinois acquired BSN
		107 - Ceramics		
1 (1)	Saint Gobain		Saint-Gobain	
2 (--)	Roca		Finceramica	Finceramica changed name into Marazzi
3 (--)	Sanitec		RHI	
4 (4)	Villeroy & Boch		Villeroy & Boch	
5 (2)	Marazzi		Iris Ceramica	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
112 - Manufacture of metal products; Casting, forging and first treatment of metal				
1 (1)	ThyssenKrupp		ThyssenKrupp	
2 (--)	Riva Group		Crown Cork & Seal	
3 (--)	Alcoa		Saint-Gobain	
4 (--)	KME Group		Bosh	
5 (--)	Norsk Hydro		Gillette	P&G acquired Gilette
153 - Wood Sawing				
1 (1)	Stora Enso		Stora Enso	
2 (2)	UPM-Kymmene		UPM	
3 (--)	Setra Group		Metsäliitto	
4 (3)	Metsäliitto		Egger	
5 (--)	Klausner Holding		Assidomän	
154 - Wood boards and other wooden products				
1 (2)	Sonae Industria		Egger	
2 (1)	Egger		Sonae Industria	
3 (4)	Pfleiderer		GKN	
4 (--)	Mohawk		Pfeiderer	
5 (--)	Kronospan		International Paper	
158 - Rubber products and rubber tyres				
1 (1)	Michelin		Michelin	
2 (2)	Continental		Continental	
3 (3)	Goodyear		Goodyear	
4 (4)	Bridgestone		Bridgestone	
5 (5)	Pirelli		Pirelli	
159 - Plastics				
1 (--)	BASF		Pechiney	
2 (--)	Dow Chemicals		Saint-Gobain	
3 (--)	Ineos		Thyssenkrupp	Ineos expandes through a series of acquisitions (EVC, ICI assets)
4 (--)	Borealis		General Electric	General Electric Plastics sold to Sabic
5 (--)	Lyondell-Basell		Solvay	Basell expands through a series of acquisitions (assets of Shell, ICI). Lyondell-Basell is a merger of Lyondell and Basell
160 - Musical instruments				
1 (--)	Gewa		Yamaha Corporation	
2 (--)	Steinway Musical Instruments		Matth. Hohner	
3 (2)	Matt Hohner AG		Boosey&Hawkes	Boosey & Hawkes is a British music publisher - no manufacturer anymore
4 (1)	Yamaha Corporation		Roland	
5 (4)	Roland		General Music	
161 - Toys and sports goods				
1 (2)	Lego		Adidas-Salomon	Adidas sold Salomon part to Amer Sports
2 (--)	Quiksilver		Lego	
3 (1&5)	Amer Sports		Mattel	
4 (--)	Brandsätter Group		Hasbro	
5 (--)	Technogym		Amer group	

Low Tech Sectors

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
134 - Oils and fats				
1 (--)	Bunge		Cargill	
2 (1)	Cargill		Montedison	
3 (4)	Archer Daniels Midland		Unilever	
4 (3)	Unilever		Archer Daniels Midland	
5 (--)	AarhusKarlshamn		Vandemoortele	
135 - Meat products				
1 (1)	Danish Crown Group		Danish Crown	
2 (--)	Vion Food Group		Uniq	
3 (--)	Westfleisch		Nestlé	
4 (--)	Nortura		Veronesi	
5 (--)	B&C Tönnies Fleischwerk		Sara Lee	
136 - Dairy products				
1 (--)	Nestle		Lactalis	
2 (1)	Lactalis		Arla foods	
3 (2)	Arla foods		Friesland Coberco	
4 (3)	Koninklijke Friesland Foods		Danone	
5 (5)	Campina		Campina	
137 - Fruit and vegetables				
1 (3)	Premier Foods		Unilever	
2 (--)	Bakkavor		Bonduelle	
3 (2)	Bonduelle		Hillsdown	Hillsdown renamed Premier Foods
4 (5)	Uniq		Procter & Gamble	
5 (--)	Kerry group		Uniq	
138 - Fish products				
1 (5)	Foodvest		Unilever	
2 (2)	Pescanova		Pescanova	
3 (--)	Marine Harvest		Uniq	
4 (--)	The Bolton Group		Royal Greenland	
5 (4)	Royal Greenland		Young's Bluecrest Seafood ltd	Young's Bluecrest Seafood ltd is now part of Foodvest Group
139 - Grain milling and manufacture of starch				
1 (--)	Associated British Foods		Montedison	Cargill acquired Montedison's share of Cerestar
2 (2)	Kellogg's		Kellogg's	
3 (1&4)	Cargill		Nestlé	
4 (5)	Archer Daniels Midland		Cargill	
5 (--)	Tate&Lyle		Archer Daniels Midland	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
		140 - Pasta		
1 (3)	Ebro Puleva		Nestlé	
2 (2)	Barilla Group		Barilla	
3 (4)	De Cecco		Rivoire et carret	Rivoire et Carret was acquired by Panzani that was then acquired by Ebro Puleva
4 (--)	Pastaficio Rana		De Cecco	
5 (--)	Divella		Mars	
		141 - Bread, pastry and biscuits		
1 (--)	Kraft Foods		Associated British Foods	
2 (2)	United Biscuits		United Biscuits	
3 (5)	Barilla Group		Danone	
4 (--)	Premier Foods		Nestlé	
5 (1)	Associated British Foods		Barilla	
1 (1)	Sudzücker		Südzucker	
2 (3)	Tate&Lyle		Danisco	
3 (--)	Tereos		Tate & Lyle	
4 (5)	Nordzücker		Montedison	
5 (2)	Danisco		Nordzucker	
		143 - Confectionery and ice cream		
1 (1)	Nestlé		Nestlé	
2 (2)-	Mars Inc.		Mars	
3 (3)	Ferrero		Ferrero	
4 (4)	CadburySchweppes		CadburySchweppes	
5 (--)	Unilever		Haribo	
		144 - Animal feed		
1 (1)	Mars Inc.		Mars	
2 (2)	Nutreco		Nutreco	
3 (--)	Procter&Gamble		Nestlé	
4 (--)	Colgate Palmolive		Cargill	
5 (3)	Nestlé		Montedison	
		145 - Alcohol, spirits, wine and cider		
1 (1&3)	Diageo		Diageo	
2 (2&5&3)	Pernod Ricard		Allied Domecq	Allied Domecq acquired by Pernod Ricard
3 (--)	Fortune Brands		Seagram	Seagram Spirit division acquired by Pernod Ricard and Diageo
4 (--)	V&S Group		LVMH	
5 (--)	Belvedere		Pernod Ricard	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
146 - Beer				
1 (3)	Inbev		Scottisch & Newcastle	
2 (2)	Heineken		Heineken	
3 (1)	Scottish&Newcastle		Interbrew	
4 (--)	SABmiller		Carlsberg	
5 (4)	Carlsberg		Diageo	
147 - Soft drinks and water				
1 (2)	Nestlé		Coca Cola	
2 (1)	Coca Cola		Nestlé	
3 (--)	Red Bull		CadburySchweppes	
4 (--)	Kraft Foods		Danone	
5 (4)	Danone		Carlsberg	
148 - Tobacco				
1 (1)	Altria		Philip Morris	Philip Morris changed its name in Altria
2 (5)	British American Tobacco		Japan Tobacco Inc	
3 (--)	Scandinavian Tobacco		Imperial tobacco	
4 (2&4)	Japan Tobacco		Gallaher group	Gallaher part of Japan Tobacco
5 (3)	Imperial Tobacco		BAT	
149 - Textiles				
1 (2)	Guinness Peat Group		Chargeurs	
2 (1)	Chargeurs		Coatsviyella	Coats viyella is now part of Guiness Peat
3 (4)	Marzotto		DMC	
4 (--)	Mohawk		Marzotto	
5 (--)	Saint Gobain		Miroglio	
150 - Leather				
1 (2)	LVMH		Gucci	
2 (4)	Hermes		LVMH	
3 (--)	PPR		Dal Maso-Miazzo	
4 (--)	Grupo Mastrotto		Hermes	
5 (--)	Christian Dior		Samsonite	
151 - Footwear				
1 (--)	Tod's		Eram	
2 (--)	Salvatore Ferragamo		Adidas-Salomon	
3 (--)	Ecco		C&J Clark	
4 (--)	ARA Shoes		Griggs (R.) group	
5 (--)	Erich Rohde KG Schuhfabriken		Stylo	

Position in 2007(2000)	EU leaders 2007		EU leaders 2000	Comments
152 - Clothing				
1 (3)	Inditex		Sara Lee	
2 (--)	M&S		LeviStrauss	
3 (--)	Christian Dior		Inditex	
4 (--)	H&M		Max Mara	
5 (--)	Next Group		Edizione Holding	
155 - Furniture				
1 (--)	Ikea		Welle	
2 (--)	Nobia		MFI	
3 (--)	Galiform		Hillsdown	
4 (--)	Nobilia		Natuzzi	
5 (--)	Alno		Silentnight	
156 - Paper, pulp and articles of paper				
1 (1)	Stora Enso		StoraEnso	
2 (3)	UPM-Kymmene		SCA	
3 (--)	Smurfit Kappa Group		UPM	
4 (4)	Metsäliitto		Metsalitto	
5 (2)	SCA		M-Real	
157 - Publishing				
1 (1)	Bertelsmann		Bertelsmann	
2 (--)	Pearson		Lagardere	
3 (2)	Lagardere Group		Axel springer	
4 (4)	Reed Elsevier		Reed Elsevier	
5 (--)	SanomaWSOY		Sony	

Among the medium high tech sectors, there is little turbulence in electrical machinery, lighting, motor vehicles, domestic appliances, and shipbuilding, but substantially more change in the machine tool industry, batteries, motor vehicle parts, and optical instruments. In the electronic valves (semiconductor) sector, changes were mostly related to spinoffs of semiconductor operations of Europe's diversified engineering and electronics firms Siemens (Infineon in DRAMs, and Epcos – a joint venture with Matsushita's semiconductor operations) and Philips (NXP). In medium-low tech industries, the influence of mergers and acquisitions has led to changes in the steel industry, cement, concrete & plaster, plastics, and glass. Market positions in the rubber and tyre industry are the most stable. In low tech sectors, there is substantial turbulence in industries where offshoring practices are more common, such as furniture, clothing, footwear, and leather. The alcohol & spirits and tobacco sectors experienced turbulence mainly due to acquisitions.

We assess the turbulence in these sectors more systematically by analysing the number and types of changes in terms of leading firms, in Table 4.4. The table shows the percentages of leadership changes across the 4 types of sectors and the type of change. A change can occur because a previously non-leading firm enters the top 5 by overtaking a previous incumbent (the second column of Table 4). A new firm can also enter the top 5 because an additional leadership position was created through a merger by two existing incumbents: in this case entry of the new firm is not necessarily related to a production share increase of the entrant. An example is the merger by HP and Compaq in the computer industry. Third, a new firm can enter the matrix by acquiring an existing leading firm. If the acquirer had no previous strong production position in the sector (e.g. such as the acquisition of Gilette-Duracell by Proctor & Gamble in the batteries sector) this again may not necessarily imply production share or concentration changes. In other cases, such as the acquisition of Aventis by Sanofi, the acquiring firm that was already active in the same sector, can attain a higher ranking in the sector and enter the top 5.

The table shows that on average 46% of the leaders in 2007 were not present as leader in the matrix in 2000. This shows a substantial turbulence with more than two new leaders on average in the sectors. The highest turbulence is in the medium to low tech sectors (54 percent) while the high tech sectors clearly have the lowest turbulence (37 percent) and in medium-high tech sectors it reaches 42 percent. In the high tech sector, a substantial part of turbulence was created by acquisitions (13 of the 37 percent points) such that on average only about 1 in 5 leaders (23 percent) was new in 2007 by overtaking an incumbent leader in 2000. Mergers between 2000 incumbent leaders have also been relatively important in the medium to low tech sectors. On average, turbulence due to new entries substituting for incumbents is very similar for medium and low tech industries, with only the high tech sectors showing substantially fewer new entries. These results provide a clear indication that R&D intensity reduces rather than increases turbulence in EU manufacturing industries. The relationship between sector characteristics, turbulence and concentration will be examined in more detail over a longer period in Section 5.

Table 4.4: Top 5 turbulence by type of sector

	% new leaders in 2007	% new leader overtaking incumbent leader	% additional position created by top5 merger	% new firm entry through acquisition of existing leader
all industries	46	37	4	5
high tech	37	23	3	10
medium-high tech	42	35	4	2
medium-low tech	54	39	6	10
low tech	48	42	4	3

5. Changes in Concentration

5.1 Introduction

This section analyses longer term trends in producer concentration in the EU. The producer concentration of an industry is an important, albeit imperfect indicator of dominance in market position held by a small number of firms. The measure as such gives no indication of the impact of imports on market competition, which has become increasingly important in recent decades. Import-adjusted measures are not the solution to remedy this problem, as they are biased by the growing importance of off- shoring by large firms in the industry (see e.g. Pryor, 2001).

Producer concentration has changed because of major changes in technology, the growing role of institutional investors, EU and world integration of markets and changes in government policies, including the deregulation of a growing number of industries. The impact of new technologies is most evident in the role of Information and Communication technologies which as supporting technologies have been very instrumental in creating efficient EU-wide or global supply chains. Moreover, the rationalization and a better exploitation of scale economies in all primary and supporting activities of the value chain: R&D, production, marketing, sales, distribution, service delivery, has led to strong restructuring. The search for efficiency gains coupled with an intensified competitive process has resulted in the disappearance of marginal producers through exit or acquisition. At the same time the integration of world markets has led to toughening competition, forcing surviving firms to concentrate their resources in those activities for which they could occupy a sustainable, and preferably leading position in the industry. Institutional investors, among which a growing number of private equity firms, are playing an important instrumental role within this ongoing restructuring process through facilitating the financing of large scale M&A.

5.2 Producer concentration in the EU anno 2007.

Using the MSM information, we calculated the C5, i.e. the sum of the production shares of the 5 leading firms as a measure of industry concentration. Figure 1 presents the concentration of industries following three groups: highly concentrated industries: industries where the C5 is higher than 50 per cent of total EU industry output, moderately concentrated industries: industries where the C5 is between 25 and 50 per cent of industry output, and weakly concentrated industries: industries where the concentration is less than 25 per cent of industry output. The vertical axis of the figure measures the share of each of these groups in total EU manufacturing output. The figure reveals that slightly more than 20 per cent of total manufacturing output is realized in industries that are highly concentrated. Most industries, accounting together for more than 60 percent of output belong to the weakly concentrated industries. Among the highly concentrated industries we find many traditional industries where scale economies are important (e.g.; soap, detergents, sugar), together with a selected number of high tech industries (aerospace, telecom) for which R&D is the major driver of growth.

Figure 5.1: Share of manufacturing accounted for by low, medium and high concentration industries.

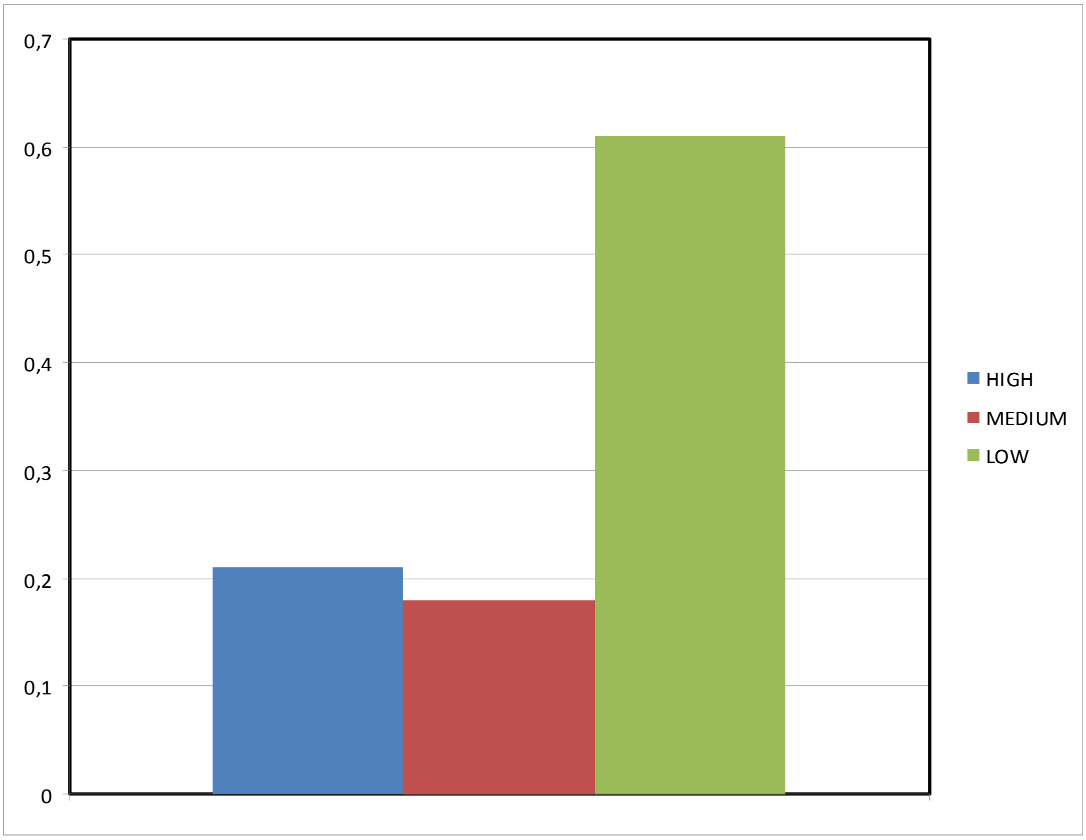


Table 5.1: sectors with lowest and highest concentration

Highest Concentration			Lowest Concentration		
	Tobacco	0,99		Textiles	0,03
	Telecom, television and radio transmitters	0,88		Furniture	0,04
	Aerospace	0,83		Batteries and accumulators	0,07
	Soap, detergents and toiletries	0,8		Publishing	0,07
	Clocks and watches	0,68		Footwear	0,08
	Sugar	0,61		Fruit and vegetables	0,08
	Clay Products	0,61		Casting, forging and first treatment of metal; manufacturing of metal products	0,08
	Musical Instruments	0,59		Meat products	0,09
	Cement, lime and plaster	0,56		Wood boards and wooden products	0,11
	Lighting equipment and lamps	0,56		Animal feed	0,12

5.3 Changes in the C5 distribution over time

Contrary to expectations, producer concentration of EU industries did not rise significantly over the period 1987-1997 when the Single Market programme took full effect. The most significant rise took place after 1997, especially in the period 2000-2007. This period was characterized by a growing openness of the EU for foreign trade and rising world integration through incoming direct investment. (See e.g. Bowen and Sleuwaegen, 2007). The global integration went together with a rapid rise in the number and value of cross-border mergers and acquisitions, in which EU firms got prominently involved.

Table 5.2 presents the shifts in the distribution of C5 across manufacturing industries, by means of the quartiles and mean of the C5 across manufacturing industries for the years 1987, 1993, 1997, 2000 and 2007. One should be careful in comparing these data over time as the scope of EU countries and industries has changed over time. The data for 1987 cover the twelve countries that were member of the EU at that time. The data in the year 2000 refer to the fifteen countries, while those for 2007 include all 27 member countries of the EU in 2007. Because of data limitations and in order to preserve meaningful indicators, in 2000 two industries had to be combined, while in 2007 several other combinations had to be made bringing the number of industries down to 61. A list of the 67 industries in 1997 and 61 industries in 2007 is provided in the appendix. As a control for the change in definition of some industries, we also examined the change in C5 distribution of the industries that remained unchanged over the whole period in table 5.3. The results in table 5.3 do not differ from the results presented in table 5.2.

Table 5.2: Changes in the C5 distribution over the period 1987,1993,2000,2007

	1987	1993	1997	2000	2007
Q1	0,12	0,12	0,14	0,19	0,13
Q2	0,22	0,23	0,23	0,28	0,32
Q3	0,37	0,38	0,38	0,39	0,49
MEAN	0,25	0,26	0,27	0,3	0,35

Table 5.3: Changes in the C5 distribution over the period 1987, 1993, 2000, 2007: comparable set of industries

	1987	1993	1997	2000	2007
Q1	0,14	0,15	0,16	0,2	0,17
Q2	0,23	0,26	0,25	0,31	0,33
Q3	0,38	0,39	0,38	0,41	0,5
MEAN	0,26	0,28	0,28	0,32	0,35
N	55	55	55	55	55

The distribution did not really change over the period 1987-1997. There is a marked increase in average producer concentration in the period 1997-2007 and a shift of the distribution affecting especially the second and third quartiles. As mentioned before, this change in the C5 distribution coincides with the period in which the EU has become increasingly integrated in the world economy and has been characterized by a strong rise in the number and value of large cross-border M&A affecting the upper part of the distribution. In 12 industries there were mergers in the period 2000-2007 between firms that were already leaders in 2000. Half of those industries can be classified as heavily concentrated, as shown in table 5.4.

Table 5.4: Industries affected by a merger(s) between existing leaders in 2000, by level of concentration in 2007

Sector	C5
Pasta	0,80
Clay Products	0,61
Cement, lime and plaster	0,56
Fish products	0,51
Aerospace	0,44
Pharmaceuticals	0,39
Batteries and accumulators	0,22
Manufacture and first processing of steel, steel tubes	0,22
Shipbuilding	0,16
Articles of concrete, plaster and cement	0,15
Glass	0,13
Textiles	0,08

5.4 Differences between types of industries

It is interesting to investigate if there any systematic change in concentration across industries. In this section we look at differences between broad groups of industries based on the Sutton typology and Single market Sensitivity typology[11].

Sutton typology

Industrial Organization theory suggests that the link between market size and (changes) in concentration depends on the nature of product competition (Sutton, 1991). Type 1 industries produce homogeneous products and have exogenous fixed costs. In these kind of industries competition can be very fierce, with firms only making sufficient profits to survive. In such industries, the larger the market is, the more firms can survive in the market, and hence the lower the concentration. The lower bound to concentration as a function of the market size is monotonically decreasing and approaches zero as market size increases. Type 2 industries produce differentiated goods and have their fixed costs endogenously determined. These industries tend to be more concentrated than Type 1 industries since the

[11] For a complete overview of the Sutton classification and the Single Market Sensitive Industries, see Annex 5.

sunk costs can be used as entry barriers to lower competition. The lower bound to concentration as a function of market size need not be monotonically decreasing, and may even increase, while the limiting level of concentration is strictly positive. Type 2 industries can be further divided based on how the product differentiation is done: through advertising, R&D or a combination of the two.

Table 5.5: Average C5 by Sutton classification

	1987	1993	1997	2000	2007
Type 1 (n=21)	0,17	0,18	0,19	0,22	0,26
Type 2 (n=34)	0,32	0,34	0,34	0,37	0,41
R&D intensive (n=21)	0,35	0,36	0,36	0,38	0,42

Notes: Homogenous goods= Homogeneous industries with no product differentiation
Type 2 -=Industries in which differentiation occurs through R&D and advertising
R&D intensive = Industries in which differentiation occurs through R&D

Table 5.5 shows that concentration in Type 1 industries is indeed considerably lower than in Type 2 industries. Over the period 1997-2000 the level of C5 continues to be significantly higher in Type 2 industries, a result which is entirely consistent with most received theory on the determinants of concentration (see Davies and Lyons, 1996). Industries where firms differentiate through a combination of R&D and advertising on average have the highest concentration both in 1987 and 2007. In 2007 the difference has narrowed to some extent. The rise in concentration in Type 1 industries may be related to the growing importance and realisation of scale economies in those industries of which the relevant market has been integrating and widening to cover the EU and beyond.

SMP typology

As shown before, the distribution of C5 concentration does not show a real noticeable impact from the Single Market programme that was implemented in the period 1987-1993. In spite of this finding, we investigate for a possible hidden impact by grouping industries according to their sensitivity to the measures of the Single market programme. Measuring the Single Market Programme (SMP) sensitivity follows the classification of industries originally presented in a study by Buigues and Ilzkovitz(1988), where they separated manufacturing industries sensitive to the Single Market programme (public procurement industries, industries characterized by non-tariff barriers to trade) from those little or not affected (see annex 5). The results are presented in table 5.6.

Table 5.6: Average C5 by sensitivity to the Single Market Program

	1987	1993	1997	2000	2007
SMP sensitive (n=25)	0,31	0,32	0,34	0,35	0,38
Public Procurement (n=9)	0,34	0,35	0,40	0,40	0,41
Other (n=30)	0,22	0,25	0,24	0,30	0,33

Note: SMP sensitive industries = Manufacturing industries most sensitive to the Single Market Programme
Public procurement industries = industries in which public procurement is important
Other industries = Industries less sensitive to the Single Market Programme

In 1987, SMP sensitive industries were concentrated more than non-SMP sensitive industries by approx. 9%. In 2007, this difference was halved to about 5 %., suggestive of a converging upward trend between the 2 categories of industries. Among the SMP sensitive industries, public procurement industries continue to be the most concentrated. The tendency towards stronger concentration for the two groups of industries occurs again after 1997 and seems to be general, suggesting that concentration has been affected by technology and world integration more than by EU integration.

5.5 Continuing leadership and concentration

Traditional industrial organization literature suggests that high levels of market concentration facilitate collusion by the leading in an industry. Since collusion leads to welfare inferior monopolistic outcomes, policy makers have been very concerned with rising levels of concentration in industries. However, more recent approaches have especially looked at the conduct of those firms and to the conditions that are deemed necessary to support collusive behaviour. The stability of market shares shows up as both as an important condition as well as an implication of collusive behaviour. As Caves and Porter (1978) noted:

> "The instability of market shares, especially among an industry's leading firms, provides a measurable indicator of rival behaviour in oligopolistic markets. The stability of shares reflects the stability and completeness of the oligopolistic bargain, as well as the size and the nature of exogenous disturbances that bargain."

The MSM methodology, being able to trace the individual leading firms over time, allows analysing the stability of market share dominance in several dimensions:

- A change in the identity of leading firms (i.e. entry of new leading firms and exit of old leaders) and/or
- A change in the leading firms' dominance (i.e. the evolution over time of production shares of the incumbent leading firms).

Over the period 2000-2007 47% of all leading matrix entries were newcomers (see section 4.2). These leaders take different shares of production in the EU. Table 5.7 list the industries with the lowest shares taken by new leaders in the production realised by the five leading firms (min=0, no new leader, max=1, production by five leading firms is completely realised by new leaders).

Table 5.7: Ten most stable industries

Low Turbulence Industry		
MSM	**Share of new leaders**	**C5**
Telecom, television and radio transmitters	0	0,88
Tobacco	0	0,99
Clocks and watches	0	0,68
Lighting equipment and lamps	0,003	0,56
Manufacture and first processing of steel and steel tubes	0,03	0,27
Manufacture of tractors and agricultural machinery	0,06	0,49
Soap, detergents and toiletries	0,08	0,8
Glass	0,12	0,39
Manufacture of electrical machinery	0,12	0,24
Railway, locomotives and stock	0,14	0,5

Most of the stable industries are characterised by a high level of concentration. In the five most stable industries the share of newcomers stayed below 5 per cent of the output accounted for by the five leading firms.

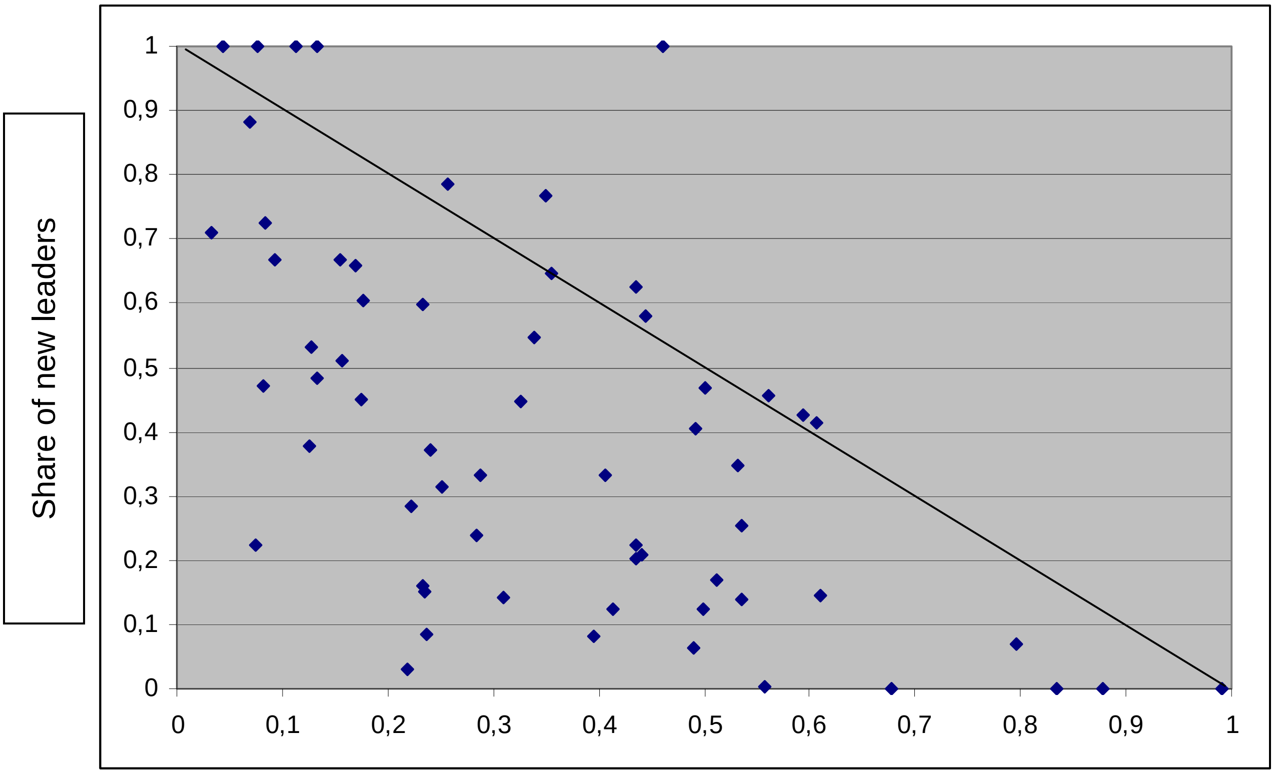
Table 5.8 shows the ten most turbulent industries for which the newcomers represent more than half of the production realized by the leaders in 2007.

Table 5.8: Ten most turbulent industries

High Turbulence Industry		
MSM	**Share of new leaders**	**C5**
Plastics	1	0,13
Furniture	1	0,04
Wood boards and other wooden products	1	0,11
Clothing	1	0,46
Footwear	1	0,08
Railway, locomotives and stock	0,88	0,07
Motor vehicles parts	0,78	0,25
Television and radio receivers, sound and video recording apparatus	0,77	0,38
Casting, forging and first treatment of metal; manufacture of metal products	0,72	0,08
Textiles	0,71	0,03

Table 5.8 reveals that the most turbulent industries are characterized by low concentration levels, facilitating drastic changing in leadership. Some moderately concentrated industries very sensitive to EU external competitive pressure, including fish products and clothing, also show a remarkable turbulence. In the latter sector, turbulence is also related to different offshoring strategies among (previously) leading firms. In order to have a more general picture of the correspondence, Figure 5.2 maps the level of concentration against the level of turbulence for the 61 industries in 2007. The scatter diagram with the added diagonal for equal values for concentration and turbulence suggests a negative relationship. Highly concentrated industries know little or no turbulence while the lowest concentrated industries are characterized by high turbulence. While lower concentration can go hand in hand with stable leadership, the mirror image does not hold: highly concentrated industries do not go together with strong turbulence.

Figure 5.2:Relationship between concentration (X-axis) and turbulence



5.6: Conclusions

Producer concentration has markedly changed because of major changes in technology, EU and world integration and changes in government policies, including the deregulation of a growing number of industries over the last two decades. The changes produced a wave of M&A affecting producer concentration in a range of industrial sectors. The most significant rise in concentration took place in the period 1997- 2007. There is a marked increase in average producer concentration over this period and a shift of the distribution affecting especially the second and third quartiles of it. This increase in concentration does not mean that leaders have stayed the same or their market shares unchanged. There has been important turbulence produced by new leaders in low and medium concentrated industries. The industries with the highest concentration ratio, in contrast, have been characterized by markedly less turbulence.

6. Key indicators of the technology dimension

In this section we describe the key technology indicators for the MSM firms and MSM sectors in 2000 and 2007. It will address the first main research question (see Section 2): “How does technological leadership vary across sectors and evolve over time along a continuing process of market integration?” We report indicators both at the level of MSM firms (section 6.1) and MSM sectors (section 6.2).

6. 1 Key technology indicators at the firm level

Coverage

A first issue is the relevance of patent statistics to examine the technology dimension across sectors. The following table gives the full distribution of all MSM firms into patent size classes. Out of the 250 MSM firms, 209 companies hold patents in 2007 (84%). Among these, 107 companies hold at least 50 patents in 2007 (43% of the total). 40% of all MSM firms hold less than 10 patents in 2007. Most of these companies are to be found in the low-tech and medium-tech sectors, reflecting that in those sectors, other strategies than technology strategies are deployed to build and sustain market leadership.

Table 6.1: Distribution of Leading MSM firms in Patent Size classes

Patents in 2007	% of Leading MSM firms
>1000	8.9%
500-1000	7.3%
100-500	19.3%
50-100	7.3%
10-50	16.6%
1-10	24.3%
0	16.2%

Key patent statistics per firm

Annex 6 contains the patent statistics for the leading firms ordered by sector. Patent statistics include the number of patents, the share of patents invented in the EU and the technology diversification index. For the year 2000, we measure patents during 1998-2000. The 2007 patent data refer to the period 2004-2006. Patent numbers are still biased downwards in this period because of the publication delays in patent applications. This will have implications for the interpretation of time trends between 2000 and 2007. Overall, MSM firms represent about one third of all patent applications invented in the EU. This is a substantial coverage reflecting that MSM firms include the major patenting firms.

Table 6.2: Overall coverage by MSM firms of EU invented EPO patents

Share of MSM firms in	2000	2007
All EU invented Patents	137324	128496
EU invented Patents held by all MSM firms	42844	40002
Share of MSM firms in All EU invented patents	31%	31%

The following table reports key technology indicators averaged for all MSM firms over all MSM sectors. Firms that are leading in more than one sector can enter the calculations more than once. On average a MSM leading firm holds 2% of EU invented patents of its MSM sector (EU technological leadership), a share which is much lower than their average share in EU production. This share has increased over time, suggesting increasing technology strength by leading MSM firms in their sector. On average, 65% of the total number of patents of an MSM firms originate (are invented in) the EU, which is higher than the EU share of total production of a typical MSM firm. This EU orientation of technology of MSM leading firms has decreased somewhat over time. In terms of technology diversification, MSM leading firms are on average highly diversified, being active in 11 technology fields. But as the Technology Diversification index indicates, many of these fields are only thinly covered. On average firms' diversification levels are such that firms are engaged in 4 technology fields if activities would have been equally spread over these fields. We see only minor changes in technology diversification over time, although the technology diversification index does suggest a weak trend towards more specialization.

Table 6.3: Technology Indicators:

All MSM firms

Average	All MSM firms
Share of sectoral EU production, 2007	7.27%
Share of EU in total Production, 2007	58.5%
EU technological leadership, 2007	2.05%
World technological leadership, 2007	1.65%
Share of EU in total firm patenting, 2007	65%
Technology Diversification index, 2007	4.13
Technology Fields, 2007	11
EU technological leadership , 2000	1.80%
World technological leadership , 2000	1.47%
Share of EU in total firm patenting, 2000	69%
Technology Diversification index, 2000	4.23
Technology Fields, 2000	11

EU versus non-EU based firms

Table 6.4 compares the different technology characteristics of EU and non-EU based MSM firms. EU based firms show a strong concentration of inventive activity in Europe: 82 percent of technology activities took place in the EU in 2007. This share of EU in total firm patenting is larger than the share of production activity in Europe, (70 percent) illustrating the ‘home bias’ in R&D recognized in the literature (see section 1). For non-EU firms the share of EU in total firm patenting is lower (30 percent), but this is almost perfectly in line with the share of the EU in their global production (29%), indicating that non-EU firms build their production leadership positions on EU-based R&D activities. On average, EU based firms have a higher EU technological leadership in their sector than non-EU based firms. For World technological leadership however, the reverse holds, indicating that the foreign firms that have succeeded in building leading production positions in the EU tend to be global technology leaders in their sector. With respect to technology diversification, non-EU based firms are more technological diversified than EU based firms. Over time, non-EU firms have narrowed their scope somewhat, reducing this differential effect.

EU versus non-EU based MSM firms

Average	Non EU27 based N=89	EU-27 based N=216
Share of EU production, 2007	7.0%	7.4%
Share of Production in EU, 2007	29.6%	70.2%
EU technological leadership, 2007	1.12%	2.43%
World technological leadership, 2007	2.26%	1.40%
Share of EU in total firm patenting, 2007	30%	82%
Tech Diversification, 2007	4.38	4.01
Tech Fields, 2007	14	10
EU technological leadership , 2000	0.93%	2.15%
World technological leadership, 2000	2.10%	1.21%
Share of EU in total firm patenting, 2000	30%	85%
Technology Diversification, 2000	4.77	3.99
Technology Fields, 2000	13	10

Technology indicators for top patenting MSM firms

Table 6.5 displays the main technology indicators for MSM firms with at least 100 patents. Not surprisingly these firms have a stronger EU technological leadership position, a value which has increased over time. In addition they also have a broader technology diversification. They are less EU based in their inventive activities as compared to low patent active MSM firms. Finally, these top patenting firms hold a statistically significant larger share of sectoral EU production, confirming a positive correlation between technology and market dominance.

Table 6.5: Technology Indicators:
Top Patenting MSM firms

Average	Top Patenting MSM firms (>100 EPO patents)
Share of sectoral EU production, 2007	8.6%
Share of EU in total Production, 2007	47%
EU technological leadership, 2007	4.11%
World technological leadership, 2007	3.21%
Share of EU in total firm patenting, 2007	59%
Tech Diversification, 2007	5.32
Tech Fields, 2007	21
EU technological leadership , 2000	3.5%
World technological leadership, 2000	2.87%
Share of EU in total firm patenting, 2000	60%
Technology Diversification, 2000	5.4
Technology Fields, 2000	21

Table 6.6 shows the list of Leading MSM firms that are most active in patenting, i.e. that have a patent count for 2007 larger than 500. In total there are 42 MSM companies in this list, representing 22% of total Leading MSM firms. As the list makes clear, most of these companies are leading in high-tech and medium-high-tech sectors. Nevertheless, there are also a few companies, leading in medium-low-tech or low-tech sectors that made it into this top patent list, such as Proctor & Gamble and Unilever.[12]

[12] See Annex 5 for technology indicators for all MSM firms.

Table 6.6: Technology indicators, 2000-2007

Top Patent Active MSM firms (Patent 2007>500)

		2007					2000				
Leading Firm	Sector	# patents	of which% in EU	tech share in sector	Tech diversification	# tech fields	# patents	of which% in EU	tech share in sector	Tech diversification	# tech fields
Siemens	117	5737	86,4	10,8	7,8	28	7220	83,215	9,8	7,4	29
Philips	121	4077	82,4	14,7	7,1	28	3297	93,657	17,7	6,6	27
Panasonic	121	3840	5,4	1,5	6,2	28	3825	0,926	0,4	6,1	29
Bosch	126	2897	91,9	6,0	8,3	28	2881	97,415	6,8	7,8	28
Sony	121	2888	13,8	3,1	4,8	28	2781	12,964	2,8	4,7	25
Nokia	120	2365	82,0	13,4	1,8	17	1938	90,636	10,0	1,7	19
General Electric	124	2142	14,7	0,3	9,2	30	1814	13,668	0,7	11,8	28
Hitachi	116	2096	1,5	0,0	10,1	29	1574	1,583	0,0	11,9	29
BASF	159	1767	87,3	0,5	7,1	27	2102	87,073	0,5	6,4	27
Fujitsu Limited	115	1738	5,8	0,5	4,4	24	221	23,152	0,3	6,4	19
Alcatel Lucent	120	1582	65,2	7,2	1,7	19	1905	81,990	7,3	2,3	24
Bayer	108	1487	66,0	4,6	6,8	26	864	87,052	3,3	6,5	27
Ericsson	120	1408	70,4	7,4	1,7	16	2415	75,207	10,2	1,7	21
Continental AG	158	1360	54,6	20,6	5,2	24	456	98,207	18,4	2,9	17
3M	131	1350	14,5	0,8	15,0	29	1449	11,406	0,5	13,6	28
Thomson	121	1348	65,2	9,4	2,8	14	962	67,626	8,9	2,7	18
NEC Corporation	115	1262	1,9	0,0	3,3	25	1856	0,916	0,0	4,2	26
The Procter & Gamble Company	144	1246	29,3	0,0	7,6	27	2130	43,788	0,1	6,7	26
STMicroelectronics	119	1167	84,2	8,1	4,7	17	1235	86,275	8,7	4,9	21
Honda Motor Co., Ltd.	129	1155	3,5	0,0	7,4	28	656	0,483	0,0	6,4	25
L'Or?al	111	1110	90,9	1,2	2,2	19	1002	96,770	2,0	3,1	21
Hewlett Packard Company	115	1106	17,3	1,0	7,2	25	1258	21,757	1,9	4,7	20
Motorola	120	1023	13,0	1,0	2,3	17	916	18,894	0,8	3,1	22
ABB	117	804	61,4	4,9	3,8	23	1118	66,043	6,1	3,3	25
EADS	130	761	99,8	29,8	5,2	25	255	97,882	5,8	8,0	22
Olympus	132	758	1,8	0,1	3,0	22	87	14,943	0,3	5,8	18
Pfizer	110	752	23,0	1,2	2,4	15	813	28,994	1,4	2,8	20
Safran Group	130	733	95,2	11,1	6,2	25	166	96,830	7,7	4,8	21
Eastman Kodak	132	702	15,7	0,3	6,4	21	1365	12,142	1,3	4,1	26
PSA Peugeot Citroen	125	691	99,3	4,3	3,5	20	369	99,187	1,1	4,0	19
Novartis	110	687	39,5	1,9	3,0	19	399	27,222	0,6	4,9	21
Dow Chemicals	108	678	13,1	0,5	3,8	27	853	17,483	0,8	4,8	28
BSH	123	669	98,6	10,8	2,7	23	412	99,353	7,5	3,0	22
GlaxoSmithKline	110	646	56,5	2,2	3,1	18	1378	51,164	4,2	3,8	21
NXP Semiconductors	119	644	86,0	3,1	5,0	13		0,000	0,0		
ZF Friedrichshafen	126	612	98,8	1,6	2,1	11	310	99,161	0,8	2,4	14
Unilever	143	561	65,9	12,5	5,1	23	611	68,625	7,6	5,0	21
Astrazeneca	110	520	72,3	2,5	2,8	19	549	80,916	2,4	3,5	18
Daimler	125	514	93,8	2,4	5,1	21	1165	91,814	5,8	5,7	25
Infineon	119	505	80,1	4,4	4,7	20	1684	81,491	13,3	4,5	25

Technology indicators by firm size

Table 6.7 displays the main technology indicators by firm size, with firm size measured as production in the EU-27 (2007) at the consolidated corporate level. We split the companies into "large" (i.e. with above sample average corporate size) and "smaller" leading firms (i.e. below sample average corporate size). It is important to remark that "small" is a relative concept in this case, as the firms included in the sample are already among the 5 largest firms in their sector. The differences in size that can be observed within this set of leading firms are likely to be determined by sectoral differences.

Table 6.7: Technology indicators by corporate firm size

Average	Large MSM firms N=104	Small MSM firms N=201
EU technological leadership, 2007	3.5%	1.3%
World technological leadership, 2007	2.3%	1.3%
Share of total EU patenting, 2007	71%	62%
Tech Diversification, 2007	5.2	3.5
Tech Fields, 2007	17	8
Share EU technological leadership, 2000	3.0%	1.2%
Share of World technological leadership, 2000	2.0%	1.2%
Share of total EU patenting, 2000	73%	65%
Technology Diversification, 2000	5.1	3.7
Technology Fields, 2000	18	8

The results confirm a positive correlation between firm size and technology strength and depth: large firms are more likely to secure a higher value for EU technological leadership and hold a broader technology portfolio. They are more likely to base their inventions in the EU as compared to smaller MSM firms. Larger firms have managed to increase their technology strength in their sectors more so than smaller firms.

Technology indicators for MSM firms in high and low-tech sectors

To further investigate the link between technology and market leadership, we examine MSM firms in High-Tech sectors and MSM firms in Low-Tech sectors separately. Not surprisingly, MSM firms in Low Tech sectors hold a lower EU technological leadership and are less technologically diversified. Nevertheless, there is a substantial heterogeneity among MSM firms in Low Tech sectors on these dimensions: the highest value for technological leadership within Low-Tech sectors is 33.5. Similarly, in terms of technology diversification the variance is high among MSM firms in low-tech sectors. For instance, the maximum value for the Technology Diversification index is 9.7.

Table 6.8: Technology Indicators:
High-tech versus low-tech MSM firms

Average	MSM firms in Low-Tech Sectors N=110	MSM firms in High-Tech Sectors N=30
Share of sectoral EU production, 2007	6.3%	11.8%
Share of EU in total Production, 2007	66%	43%
EU technological leadership, 2007	1.3%	4.4%
World technological leadership, 2007	1.2%	2.7%
Share of EU in firm patents, 2007	63%	50%
Technology Diversification, 2007	3.31	4.43
Technology Fields, 2007	6	19
EU technological leadership, 2000	1.2%	3.6%
World technological leadership, 2000	1.1%	2.4%
Share of EU in firm patents, 2000	66%	58%
Technology Diversification, 2000	3.6	4.5
Technology Fields, 2000	5	20

For MSM firms in High-Tech Sectors, we find that these firms hold a higher share of sectoral patents (technological leadership), both at the EU level and worldwide, as compared to the average MSM firm (2.05%). Compared over time this differential has increased (from 2.0 in 2000 to 2.14 in 2007), suggesting that MSM firms in High-Tech Sectors have succeeded in increasing their technological dominance more than firms in other sectors. There is some evidence for a slight reduction in technology diversification in high tech sectors, but the clearest trend is a reduction in the importance of EU locations for technology activities.

Low-Tech sectors as well as High-Tech sectors are characterized by a considerable degree of within-sector heterogeneity in technological activities. To further illustrate this heterogeneity within sectors, Table 6.9 shows key patent statistics for firms in high-tech sectors, while Table 6.10 illustrates the heterogeneity in technology strategies in one particular low-tech sector: the sugar industry.

Table 6.9: Technology (patent) indicators for firms in high tech sectors, 2000-2007

Leading Firm	Sector	2007				2000			
		# patents	of which% in EU	tech share in sector	Tech diversification	# patents	of which% in EU	tech share in sector	Tech diversification
110 - Pharmaceuticals									
Novartis	110	687	39,5	1,9	3,0	399	27,222	0,6	4,9
Sanofi-Aventis	110	430	79,8	2,5	2,7	338	86,076	1,6	3,5
GlaxoSmithKline	110	646	56,5	2,2	3,1	1378	51,164	4,2	3,8
Pfizer	110	752	23,0	1,2	2,4	813	28,994	1,4	2,8
Astrazeneca	110	520	72,3	2,5	2,8	549	80,916	2,4	3,5
115 - Computer and Office Equipment									
Hewlett Packard	115	1106	17,3	1,0	7,2	1258	21,757	1,9	4,7
Canon	115	47	25,5	0,1	7,0	94	18,085	0,1	5,1
Dell	115	2	0,0	0,0	1,6	0	0,000	0,0	
Fujitsu Limited	115	1738	5,8	0,5	4,4	221	23,152	0,3	6,4
NEC Corporation	115	1262	1,9	0,0	3,3	1856	0,916	0,0	4,2
116 - Insulated Wires and Cables									
Schneider	116	21	33,3	0,0	2,7	89	31,461	0,1	3,2
Hitachi	116	2096	1,5	0,0	10,1	1574	1,583	0,0	11,9
Alcatel Lucent	116	1582	65,2	0,4	1,7	1905	81,990	1,2	2,3
Infineon	116	505	80,1	0,1	4,7	1684	81,491	0,4	4,5
General Cable	116	44	2,6	0,0	4,2	1	100,000	0,0	2,0
120 - Telecom, television and radio transmitters									
Ericsson	120	1408	70,4	7,4	1,7	2415	75,207	10,2	1,7
Nokia	120	2365	82,0	13,4	1,8	1938	90,636	10,0	1,7
Alcatel Lucent	120	1582	65,2	7,2	1,7	1905	81,990	7,3	2,3
Siemens	120	5737	86,4	12,9	7,8	7220	83,215	13,9	7,4
Motorola	120	1023	13,0	1,0	2,3	916	18,894	0,8	3,1
121 - Television and radio receivers, sound and video recording apparatus									
Harman International	121	233	73,9	2,2	4,7	75	78,222	1,3	2,2
Panasonic	121	3840	5,4	1,5	6,2	3825	0,926	0,4	6,1
Philips	121	4077	82,4	14,7	7,1	3297	93,657	17,7	6,6
Sony	121	2888	13,8	3,1	4,8	2781	12,964	2,8	4,7
Thomson	121	1348	65,2	9,4	2,8	962	67,626	8,9	2,7
130 - Aerospace									
BAE Systems	130	101	50,0	0,1	6,6	146	81,279	3,3	7,4
EADS	130	761	99,8	29,8	5,2	255	97,882	5,8	8,0
Finmeccanica	130	89	100,0	1,6	9,6	1246	88,537	1,0	5,2
Rolls-Royce Group plc	130	336	96,2	5,0	3,6	154	84,632	2,5	3,1
Safran Group	130	733	95,2	11,1	6,2	166	96,830	7,7	4,8

The sugar industry illustrates the heterogeneity in low tech sectors. While two firms hold no patents, top market leader Danisco has fairly sized and increasing patent holdings.

Table 6.10: patent indicators for firms in the sugar industry

Leading Firm	Sector	2007				2000			
		# patents	of which% in EU	tech share in sector	Tech diversification	# patents	of which% in EU	tech share in sector	Tech diversification
Danisco	142	128	42,3	15,0	4,7	88	88,516	17,7	4,4
Nordzucker	142	0	0,0	0,0		0	0,000	0,0	
Sudzucker	142	21	96,8	0,0	1,8	34	99,265	4,2	5,2
Tate & Lyle	142	18	42,1	5,3	4,6	12	48,545	2,1	3,6
TEREOS	142	0	0,0	0,0		28	85,714	4,2	3,7

This heterogeneity in high tech as well as low-tech sectors provides scope for the analysis of sources and impact of technology strategies. It particularly suggests the importance of firm level characteristics over sector characteristics for the technology-market leadership relationship. In Section 7 we examine this relationship in more detail.

6. 2. Key technology indicators at the sectoral level

Sectoral Coverage

Annex 6 displays for all sectors the share which MSM firms hold in the total number of EU-based patents allocated to that sector. This coverage of sectoral patents by MSM firms is on average markedly lower than their coverage of EU production (10% versus 36%).[13] As Annex 6 illustrates, the coverage differs substantially across sectors. In High-Tech sectors, the patent coverage increases to 22%, in Medium-High-Tech sectors this is 14%. Table 6.10 displays the 10 sectors with the highest patent coverage by MSM firms. This list contains a number of high-tech sectors, such as Aerospace, Telecom & TVs, but also some low tech sectors such as sugar. All the sectors with high coverage of patents, also display a high share by MSM firms in total EU production, which is suggestive of a positive link between product and technology leadership.

[13] Section 6.3 will discuss patenting firms that are not included in the group of MSM matrix firms in more detail.

Table 6.11: Sectors in which MSM firms hold large shares of sectoral patents (technology leadership)

Sector		Share of MSM firms in total Sector EU Patents 2007	Share of MSM firms in total Sector EU Patents 2000	Share of MSM firms in total Sector EU Production
142	Sugar	20,35	28,30	61,06
123	Dom Appliances	21,75	15,71	44,16
124	Lighting	22,85	13,54	55,66
109	Paint	25,17	6,92	43,62
121	TVs	30,96	31,14	34,94
134	Oils&Fats	34,74	34,47	43,62
120	Telecom	41,89	42,21	87,86
130	Aerospace	47,54	20,30	83,34
111	Cosmetics	48,70	51,95	79,56
158	Rubber	62,46	62,48	50,17

The relationship between patent coverage and production concentration is also clear when examining the average patent-coverage of MSM leaders in High-Concentration sectors (concentration >50%), which is in 2007 20 percent - twice as high as the average coverage. For High-Tech sectors with high concentration, the patent coverage increases to 25%.

Key patent statistics per type of sector

Annex 6 reports patent statistics per sector, such as the share of patents invented in the EU, EU technological leadership and the technology diversification index for 2007. Table 6.11 summarizes the statistics for all sectors, and statistics split by type of sectors. We single out SMP sensitive sectors and the sectors identified as differentiated through R&D and/or advertising (Sutton Type 2 sectors, see annex 8 for definitions).

Table 6.12: Technology indicators of MSM firms by type of sector

Average	All Sectors	SMP sensitive	Sutton Type 2	High Conc
Share of firm in sectoral EU production, 2007	7.27%	8.01%	8.8%	11.7%
EU technological leadership, 2007	2.05%	2.73%	3.09%	3.24%
Technology Diversification, 2007	4.01	4.68	4.12	4.17
Technology Fields, 2007	11	14	14	13
Share of EU in firm patents, 2007	67%	67%	61%	62%
EU technological leadership, 2000	1.80%	2.37%	2.72%	2.90%
Technology Diversification, 2000	4.23	4.66	4.34	4.31
Technology Fields, 2000	11	14	14	13
Share of EU in firm patents, 2000	68%	67%	63%	67%

Table 6.12 illustrates that the scores on all technology dimensions (technological leadership, share of EU in firm patents and diversification) are on average higher in SMP sensitive sectors, Sutton Type 2 sectors (differentiated sectors) and high-concentrated sectors. MSM firms in SMP sensitive and differentiated sectors clearly hold larger technological leadership confirming the importance of holding a leading position in these sectors. Especially in High-Concentration sectors, MSM firms hold more dominant technology positions. The only exception is the EU bias in location of inventive (R&D) activities which is lower in all these types of sectors as compared to the average.

6. 3. Main non-top5 patenting firms in MSM Sectors

As the previous sections have show, MSM firms, which are by definition manufacturing leaders in the EU, are also important patent holders in several sectors. Nevertheless their strength in patent positions seems less outspoken than their dominance in manufacturing. Therefore, we examined all patent holders for the technology classes that were assigned to each of the MSM production sectors. Table 6.13 lists the main patent holding firms that are not among the MSM firms in that sectors.

In some specific industries, where the shares in EU sectoral patents of leading MSM firms are high, there are few or no firms outside the matrix holding large numbers of sector-specific patents: for instance, rubber and tyres, sugar, telecommunications, paint & ink, aerospace, and soap. In quite a few other sectors, firms outside the MSM matrix have significant patent holdings. One explanation for this is the imperfect correspondence between production sectors and patent technologies. Several patent technology fields are specified in too general terms to be assigned to one specific production sector and had to be assigned to multiple sectors (see section 3.3. and annex 2). This implies that firms with patents in these more generic technologies can enter as patent holders in multiple industries in which they are not leading in manufacturing. This pattern occurs in sector clusters around metal (steel, non-ferrous metals), clay and cement, food products (starch, pasta, bread), and wood products, among others.

A second reason for the presence of non-leading MSM firms among large patent holders of sector-specific patents relates to the diversified and substantial patent portfolios of several leading technology firms. In many cases, these are matrix firms that also hold patents in related sectors in which they are not among the top 5 leading manufacturers. Examples are Siemens, BASF, Philips, Roche, L'Oreal, Bosch, BMW, Snecma/Safran, Unilever, Nokia and Danisco. Hence, sector-specific large patent holders may not be among the top5 leading firms of a particular sector, but the patent holdings are included in the technology dimension of the matrix exercise through the diversified patent holdings of matrix firms. In terms of overall patent holdings, the matrix firms are more dominant and hold a larger share of EU patents than in terms of sector-specific patent holdings.

Third, in some cases, firms have reduced production capacity or manufacturing in mature industries but still maintain a broad R&D base and patent portfolios to benefit from licensing activities. A good example is Philips, which has divested a number of activities (consumer electronics, semiconductors) but remains active in R&D in relevant fields. In other cases, firms may be leaders in their sector but have fallen out of the manufacturing top 5 due to the offshoring production abroad. This pattern appears important in the footwear and clothing industries.

In the analysis that follows in Section 7, the relationship between technological leadership and production leadership will be analyzed, where the role of sector specific differences and the presence of broader diversified technology portfolios (technology diversification) will be specifically taken into account.

Table 6.13: Main patent holders in the sector not among the top 5 leading manufacturers

MSM code	**MSM sector**	**Main patent holders in the sector: non-leading firms**
101	steel and steel tubes	**Siemens,** SMS Demag, Sandvik, Outotec
102	Non- ferrous metals	**Siemens,** SMS Demag, Sandvik, Outotec
103	Clay Products	Mitubishi, Arkema, **BASF, Bosch,** Alcan
104	Cement, lime and plaster	Mitubishi, Arkema, **BASF,** Alcan
105	Articles of concrete, plaster and cement	Mitubishi, Arkema, Alcan, VKR, **BASF**
106	Glass	Schott, Mitsubishi, , Arkema
107	Ceramics	Mitubishi, Arkema, **BASF, Bosch,** Alcan
108	Chemical Products	Degussa, Merck
109	Paint & ink	**Air Liquide**
110	Pharmaceuticals	**L'Oreal,** Boeringer Ingelheim, **BASF, Henkel**
111	Soap, detergents and toiletries	Clariant
112	manufacture of metal products	Dorma, **Siemens,** Winkaus, **Bosch, Hilti**
113	Tractors and agricultural machinery	Dreier & Compnay, Bernard Krone, Lely Enterprises
114	Manufacture of machine tools	Black&Decker, **Siemens,** Sandvik
115	Computer and office equipment	**Philips, Siemens, SAP, Nokia, Thomson**
116	Insulated wires and cables	**Siemens,** Delphi, **ABB, Bosch, Schneider**
117	Manufacture of electrical machinery	**Bosch,** Delphi, **Schneider**
118	Batteries and accumulators	**Siemens, Bosch,** ST **Microelectronics, Philips,** Areva
119	Electronic valves, tubes and other components	**Philips, Siemens**
120	Telecom; television and radio transmitters	-
121	Television, radio, sound or video recorders	**Nokia, Siemens, Bosch**
122	Measuring, checking, testing instruments	**Siemens, Philips, Hoffman La Roche**
123	Domestic electric appliances	**L'Oreal,** SEB
124	Lighting equipment and lamps	Valeo, Hueck & Company
125	Motor vehicles	**Bosch, Siemens,** Renault, **BMW**
126	Motor vehicles parts	Renault, Peugeot-Citroen, **BMW,** Behr
127	Shipbuilding	Snecma, **Bosch, Rolls Royce**, **ZF Friedrichshaven, Siemens**
128	Railway, locomotives and stock	**Snecma,** Franz Plasser, **Bosch**
129	Cycles and motor cycles	**Snecma,** Campagnolo, **Bosch, BMW**
130	Aerospace	**Siemens**
131	Medical instruments	**Hoffman La Roche**, Brainlab, **SCA Hygiene products**
132	Optical instruments	**Philips,** Essilor, Leica, **Thomson**
133	Clocks and watches	Polar Electro, Lange Uhren, Timex
134	Oils and fats	**Friesland Brands**
135	Meat products	**Unilever,** Pura Biochem, Schroder, Novozym, **Danisco**
136	Dairy products	**Danone, Unilever, Danisco**
137	Fruit and vegetables	**Unilever,** Pura Biochem, Schroder, Novozym, **Danisco**
138	Fish products	**Unilever,** Pura Biochem, Schroder, Novozym, **Danisco**
139	Grain milling and manufacture of starch	Novozym, Puratis, **Danisco,** CSM, **Unilever**
140	Pasta	Novozym, Puratis, **Danisco,** CSM, **Unilever**
141	Bread, pastry and biscuits	Novozym, Puratis, **Danisco,** CSM, **Unilever**
142	Sugar	**Glaxo**
143	Confectionery and ice cream	Nestec, **Kraft,** Gumlink, Tetra Laval
144	Animal feed	Novzym, **BASF,** Inve, DSM, Cognis
145	Alcohol, spirits, wine and cider	Krones, Lallemand
146	Beer	Krones, Novozym
147	Soft drinks and water	**Unilever,** Nutricia, DSM, **Friesland Brands,** Cognis
148	Tobacco	Hauni, International Tobacco Machinery, Reemtsma
149	Textiles	**BASF, L'Oreal,** Fleissner, Dystar, **SCA Hygiene Prodcuts**
150	Leather	Kiefer, Sprenger
151	Footwear	Lange, Salomon, Geox, Diadora Invicta, Head Technology
152	Clothing	Salomon, Coluplast, Falke, Blucher, DBA
153	Wood sawing	Diefenbacher, Homag, Systemas TW, IMA, Putzmeister
154	Wood boards and other wooden products	Diefenbacher, Homag, Systemas TW, IMA, Putzmeister
155	Furniture	**BSH,** Julius Bloom, Hartmann, Hettich, Wincor Nixdorf
156	Paper, pulp and articles of paper	Voith, Giesecke & Devrient, Metso, **BASF,** Hueck
157	Publishing	**ASML, Carl Zeiss, Agfa, Philips, Eastman Kodak**
158	Rubber products and rubber tyres	-
159	Plastics	**L'Oreal, Siemen**s, Legrand, Sidel
160	Musical instruments	Tectus, **Philips, Alcatel, Nokia**
161	Toys and sports goods	**Salomon, L'Oreal,** Skis Rossignol, Tyrolia, **Philips**

7. The Relationships between Technological leadership and Market Leadership

In this section, we focus on the relationship between technology and market leadership. The section will cover the research questions 2-4 listed in Section 2.

7. 1. Construction of Variables

Before we present the analysis, we first need to discuss which constructs we will use to identify technology and market leadership and their changes. Several indicators will be used. In all of the cases, our interest is in leadership in the EU area. Observations in the analysis in this section are leading firms in each MSM sector. Firms active as leader in multiple sectors occur more than once as an observation, but each time with a different sectoral market share and sectoral technological leadership position.

For ***technological leadership***, we use the shares that firms hold in the total number of (EU-originating) patents of their sector, and the changes therein. Second, we use this information to construct dummies for technological leadership. We construct a dummy, *patent leader*, which takes the value of 1 if an MSM firms holds a share in its sector's patents which is above the sectoral average and if it holds at least 1% of sectoral patents: 83 observations have a value of 1 for this dummy. In addition, we construct a dummy, *top patent leader* that takes the value of 1 for those MSM firms that hold the largest number of patents in their sector, provided that they hold at least 1% of sectoral patents. 60 observations have a value of 1 for this dummy.

For ***market leadership***, the firms selected in the MSM database are already among the Top 5 leading producers in the EU. To further differentiate among those MSM firms along market leadership, we identify the largest EU producer (*top production leader*). We also use the shares which MSM firms hold in the total EU production. In addition, we include a dummy which takes the value of 1 for those MSM firms that are the largest both in terms of production *and* in terms of patents for their sector. These firms combine top technological leadership and top market leadership positions (15 observations).

For ***changes in technological leadership***, we compare the sector shares in EU based patents between 2000 and 2007. We construct a variable that takes the value of -1 if the firm grows slower than the sector average: a value of 1 if the firm growth faster than the sector average and a value 0 if there are no patents in 2000 or 2007 or if there is zero growth;

Firms that grow slower than their sector average will see their technological leadership decrease over time and vice versa.

For ***changes in market leadership***, we identify those firms that are in 2007 new among the top 5 leaders in the sector, as compared to 2000. These are the *new leading firms* to be compared with the *incumbent* MSM firms. In addition, we construct a dummy for incumbents that takes a value of 1 if the firm grows faster than the sector average, and a value of 0 if the firm grows slower than the sector average. Firms that grow slower than their sector average will see their production leadership decrease over time and vice versa.

7. 2. Relating technological leadership and market leadership

Characterizing Technology Leaders

Table 7.1 contains summary statistics for the subset of 83 technology leading firm. The first row clearly shows that technology (patent) leading firms have a significantly higher share of total sectoral production as compared to non-technology (patent) leading MSM firms. Patent leaders hold on average 11.58% of EU production of their sector, a significantly higher share than for the average MSM firm. This supports a positive correlation between technological leadership and market leadership. The average production share is only slightly higher for the top patent leading firms, suggesting that it is often a close call among the technology leaders with respect to production shares. Patent leaders also have broader technology portfolios, particularly the top patent firms.

Table 7.1: Characterizing Technology Leading Firms

Average	All MSM firms	patent leader N=83	Top patent leader N=47
Share of sectoral EU production, 2007	7.27%	11.58%	11.67%
EU technological leadership, 2007	2.05%	6.77%	8.65%
World technological leadership, 2007	1.65%	4.80%	5.20%
Technology Diversification, 2007	4.13	4.89	5.38
Technology Fields, 2007	11	18	20
Share of EU in firm patents 2007	65%	74%	78.5%
EU technological leadership, 2000	1.80%	5.58%	6.75%
World technological leadership, 2000	1.47%	3.89%	4.11%
Technology Diversification, 2000	4.23	4.89	5.41
Technology Fields, 2000	11	17	19
Share of EU in firm patents, 2000	68%	74%	81%

The link between technology leading position and market leading position can be further illustrated through the observation (not in Table 7.1) that almost 1 out of every 3 patent leader also holds the top spot in EU production in their sector. Of these patent leader slots, 82.5% are taken by EU-based firms, much higher than expected. Only 11 of these slots are taken by new matrix entrants, leaving 86% of these slots filled by incumbent entries.

Characterizing market leaders

Table 7.2 contains summary statistics for the subset of 60 top production leaders. The technological leadership of top production leaders in total sector patents is strong, confirming again a positive correlation between technology and market leadership, but this time from the opposite angle. This differential between the top producer and the other MSM firms in the sector has increased over time (1.46 in 2000 versus 1.63 in 2007). The top producers are also more diversified in their technology portfolio and somewhat more biased in favour of the EU for locating their inventive activities, but the latter effect is statistically not significant. The difference between top production leaders in terms of technology share is even greater if world technological leadership values in the sector are compared. Top production leaders have a worldwide technology share in the sector that is about twice as large as the average.

Table 7.2: Characterizing Top Production leaders

	All MSM firms	Top Production Leader N=60
EU technological leadership, 2007	2.05%	3.35%
EU technological leadership, 2000	1.80%	2.64%
World technological leadership, 2007	1.65%	3.02%
World technological leadership , 2000	1.47%	2.46%
Share of sectoral EU production, 2007	7.27%	14.63%
Share of EU in total Production, 2007	58.5%	61%
Technology Diversification, 2007	4.13	4.54
Technology Fields, 2007	11	14
Share of EU in firm patents, 2007	65%	69.5%
Technology Diversification, 2000	4.23	4.59
Technology Fields, 2000	11	14
Share of EU in firm patents, 2000	68%	70%

The positive link between top production positions and top technology positions is further illustrated in the table 7.3. The table shows that one out of 4 top production leaders also hold the top position in their sector in terms of patents.

Table 7.3 Top production leaders and technological leadership

	All MSM firms	Top production Leader (N=60)
% patent leaders	26%	42%
% top patent leaders	15%	25%

Characterizing firms with both technology and market leadership

There are in total 15 firms that simultaneously hold the top 1 slot for patents and production in their sector. Table 7 4 lists these companies, together with a few of their characteristics.

Table 7.4: Firms with both top patent and top production positions

Firm	MSM sector	EU27 Based	Large Patents portfolio	Tech fields	Patent Share Growth	Production Share Growth
Saint-Gobain	106	1	2	24	1	0
Saint-Gobain	107	1	2	24	-1	1
BASF	109	1	3	27	1	2
P&G	111	0	3	27	-1	1
Bosch	114	1	3	28	1	1
Hewlett Packard	115	0	3	25	-1	1
Alcatel Lucent	116	1	3	19	-1	1
Siemens	117	1	3	28	1	1
STMicroelectronics	119	1	3	17	-1	0
Nokia	120	1	3	17	1	1
BSH	123	1	2	23	1	1
Bosch	126	1	3	28	-1	2
Piaggio	129	1	1	8	0	1
EADS	130	1	2	25	1	2
Michelin	158	1	2	18	-1	2

Note: Large patent portfolio=1 if the number of patens in 2007 > 100; 2 if patents <1000 and 3>1000; patent share growth=-1 if slower than sector average, =1 if faster than sector average; production share growth= 2 for new Leading positions, 1 for faster growth and 0 for slower growth.

The list contains a mixture of low and high-tech sector positions. It only includes P&G and HP as non-EU firms. Most of these firms have a wide and broad technology portfolio (with the exception of Piaggio). But in terms of dynamics we see a wide heterogeneity, with both faster and slower growth in terms of patents and in terms of production, suggesting the difficulty of building/maintaining a combined leadership in technology and production. Table 7.5 further characterizes these leading firms. They are clearly much larger compared to the average MSM firms, both in terms of production share as well as in terms of patent shares. They are also substantially larger in terms of production and are stronger in technology leadership as compared to firms that only hold a top production position (Table 7.2), or a top patent position (Table 7.1). In addition they have substantially expanded the scope of their technology portfolio and currently hold a broad technology portfolio, again broader than firms that are top firms in just one of the two leading dimensions. With respect to the EU location of their R&D activities, we see that although the patent and production leaders have a higher than average EU orientation, this is decreasing over time.

Table 7.5: Characterizing Top Production and Technology Leaders

Average	All MSM firms	Top patent & Production Leaders
Share of sectoral EU production, 2007	*7.27%*	*19.9%*
Share of EU in total Production, 2007	58.5%	56%
EU technological leadership, 2007	*2.05%*	*10.43%*
World technological leadership , 2007	*1.65%*	*6.15%*
Technology Diversification, 2007	4.13	5.76
Technology Fields, 2007	11	23
Share of EU total patenting, 2007	65%	77.4%
EU technological leadership , 2000	1.80%	7.59%
World technological leadership , 2000	1.47%	5.16%
Technology Diversification, 2000	4.23	5.79
Technology Fields, 2000	11	22
Share of EU in firm patents, 2000	68%	82%

7. 3. Changes in Market and Technological leadership

In this section we first compare the incumbent MSM firms, i.e. those manufacturing leaders in the matrix in 2007 that already held a leading position in their industry in 2000, to those MSM firms that are "new" entrants in the matrix, i.e. firms that did not yet have a leading market position in 2000. Second, for the incumbent MSM firms we further analyze changes in technology and market leadership between 2000 and 2007.

Comparing new and incumbent leading firms

A first important observation is that 63% of entrants to the MSM matrix hold no patents; this is much higher than the average among MSM matrix firms (15%). For those new entries that hold patents, they are not more likely than incumbents to have a higher growth rate in EU based patents. Table 7.6 compares the average characteristics of the new entries with the incumbent observations. It shows that new matrix entrants hold weaker EU technological leadership positions as compared to incumbents. In addition, their technology portfolio is less diversified. Unlike their production, which is as EU oriented as incumbents, patents of entrants are less EU-based.[14]

Table 7.6: Characterizing MSM Entrants and Incumbents

Average	All MSM firms	New Entries	Incumbents
Share of sectoral EU production, 2007	7.27%	4.71%	10.2%
Share of EU in total Production, 2007	58.5%	59%	58%
EU technological leadership , 2007	*2.05%*	*1.01%*	*3.24%*
World technological leadership , 2007	*1.65%*	*0.89%*	*2.51%*
Technology Diversification, 2007	4.13	3.91	4.32
Technology Fields, 2007	11	9	13
Share of EU in firm patents, 2007	65%	61%	69%

As the previous sections have detailed, turbulence through new leading firm entry is much higher in lower technology sectors. This may explain why new leading firms on average have a lower technology intensity compared to incumbents. Table 7.7 compares entrants and incumbents only in the subsets of low/medium technology sectors and high-tech sectors.

Table 7.7: Characterizing MSM Entrants: Low-tech versus High-tech sectors

Average	New Entries Low/Medium -Tech N=152	Incumbents Low/Medium-Tech N=123	New Entries High-Tech N=11	Incumbents High-Tech N=19
Share of sectoral EU production, 2007	4.3%	9.8%	10.1%	12.8%
EU technological leadership , 2007	0.7%	3.1%	4.8%	4.2%
Technology Diversification, 2007	3.8	4.4	3.9	4.0
Technology Fields, 2007	8.5	12	21	18

Although in high-tech sectors the probability of MSM entry is lower, the firms that do enter into leading positions in high-tech sectors are very similar in profile as compared to the incumbent MSM firms. Their production share is only slightly lower compared to the incumbents and in terms of technological leadership they even are scoring better than the

[14] This is due to the fact that a disproportional share of entrants is based outside the EU. See section 7.4

incumbents. The technology diversification index is similar while the number of technology fields in which MSM entrants are active is higher than that of incumbents. All this, although based on a limited number of observations, suggests that entry in high-tech sectors is based on a strong and broad technology portfolio. The multivariate analysis of section 7.4 will examine these differences in more detail, correcting for the sector composition of entrants.

Changes in leadership by incumbent MSM firms

In this paragraph, we restrict analysis to incumbent MSM firms with positive patent holdings to examine changes in technological leadership. Among the MSM firms that hold patents, we can distinguish those whose technological strength increases faster or slower than the sectoral average. The former will increase their technological leadership, while the latter will see their leadership position decline. Table 7.8 details the characteristics of these two groups of firms. Firms that have a relatively slower patent growth are those that started off with a higher leadership position, indicating on average a process of technology catching-up in MSM sectors. In terms of technology diversification, both groups of firms are not very different. Slower patent growth is associated with a decline in the share of technological activities conducted within the EU (share of EU in firm patents), suggesting that part of the smaller growth in EU technological leadership is due to R&D internationalization.

Table 7.8: Incumbents with patent holdings: Growth in technology (patent) leadership

Average	Fast EU-based Patent Growth (N=90)	Slow EU-based patent Growth (N=63)
Share of sectoral EU production, 2007	*8.64%*	*9.64%*
Share of EU in total Production, 2007	52%	53%
EU technological leadership, 2007	*4.04%*	*3.25%*
World technological leadership, 2007	3.49%	2.21%
Technology Diversification, 2007	4.5	4.6
Technology Fields, 2007	17	16
Share of EU in firm patents, 2007	71%	64%
EU technological leadership, 2000	*2.62%*	*4.66%*
World technological leadership, 2000	2.30%	3.04%
Technology Diversification, 2000	4.64	4.63
Technology Fields, 2000	16	18
Share of EU in firm patents, 2000	71%	70%

Note: Slow patent growth firms have a growth in EU patent numbers, which is slower than their sector average. Conversely, fast patent growth firms have a growth in EU patent numbers, which is higher than their sector average. Excluded are firms that have no patents in 2000 or 2007.

Finally, we link technology growth more directly to changes in product leadership for incumbent MSM firms. Table 7.9 shows that firms with slower production growth have a higher probability to have no patents compared to firms with higher production growth. In addition, once controlled for having patents, these firms are less likely to have a faster technology growth. Incumbent firms that see their product market share increasing over time are also more likely to increase their technology share. All this confirms a positive relationship between technology leadership growth and market leadership growth.

Table 7.9: The relationship between growth in technological leadership and growth in product market leadership

	Prod Growth Slower (#)	**%**	**Prod Growth Faster (#)**	**%**	**All firms (#)**	**%**
NoTech or NoTechGrowth	27	*45*	28	*31*	152	*50*
Tech Growth Slower	14	*23*	25	*27*	63	*21*
Tech Growth Faster	19	*32*	27	*42*	90	*29*
Total	**60**	***100***	**91**	***100***	**305**	***100***

Note: the last columns (all entries) is included for reference. It includes beyond the faster and slower growing incumbents also the new MSM entries. Chisq=24.56***

7. 4. Multivariate analysis of the relationship between Technological leadership and Market Leadership

In this last section, we turn to a multivariate analysis of the relationship between technological leadership and market leadership. This will allow confirming whether the positive relationship observed in the previous sections is robust to correction for other firm and industry characteristics. We also need to consider the simultaneity in the relationship, with *Technological leadership* influencing *Market Leadership*, but *Market Leadership* also affecting *Technological leadership*. To this end we will use lagged structures of the variables whenever appropriate.

Determinants of Market Leadership

We start the analysis with the determinants of *Market Leadership*. Market leadership is defined as the share an MSM firm holds in the total production in the EU of its sector in 2007 (share of sectoral EU production**)**. As explanatory variables we are particularly interested in *Technological Leadership*, as measured by the share an MSM firm holds in total sector patents invented in the EU. This technological leadership variable should be measured preceding 2007, the year of market leadership identification. As the 2007 variable for Technological leadership is based on patents in the period 2004-2006, it can be included as “lagged variable”. Beyond our core independent variable of interest, we will also include sector controls and other firm characteristics.

Table 7.10. Determinants of the Share of sectoral EU production, 2007

	(1) All sectors	(2) High Concentration	(3) SMP sensitive	(4) High & Medium Tech
EU technology leadership	**.927*** **	**1.207*** **	**1.023*** **	**1.057*** **
Presence in Top 5 in 2000 (Incumbency)	.044***	0.087***	0.037**	0.046***
Interaction	-0.76***	-1.116***	-0.541**	-0.641***
(N, StatSign of F-test, Adjusted R^2)	*305, ***, .431*	*135, ***, .350*	*145,***, .284*	*195, ***, .321*

Note: Industry Dummies Included; Method: OLS[15], ***=1% significance; **=5%, *=10%,

The results of Table 7.10 (column 1) provide strong support for the positive relationship between *Technological leadership* and *Product Market Leadership*. The effect of EU technological leadership on shares in sector production in the EU is positive, highly significant and sizeable across all MSM sectors, confirming the importance of technological leadership for market leadership.

Incumbent MSM firms manage to hold a significantly higher production share, as compared to new MSM firms. Interestingly, for incumbent MSM firms, technological leadership is less important for boosting their production share, as the significantly negative interaction effect between incumbency and patent share suggests. Hence, although there is a strong incumbency effect on product market leadership, technological leadership seems less important for incumbents to sustain their product market leadership. For new entrants, in contrast, technological leadership is very important. Although on average entrants were found to hold less strong technology positions (see section 6), those few that do have a strong technology position are rewarded for this in terms of higher production shares. This is

[15] Tobit regressions controlling for the restriction of the dependent variable between 0 and 1 gives almost identical results.

a result that is highly robust across various specifications. If we include EU technological leadership *in 2000* (not reported) the effect is still positive and significant, but smaller in magnitude: the comparable results in regression (1) would give as coefficient 0.623***. This is reminiscent of the depreciation of the value of knowledge activities over time. If we include *World technological leadership* (the share of the firm in worldwide sectoral patents) the effect is similar and even slightly stronger. Also, when substituting the top patent leader dummy to proxy for technological leadership, similar results are obtained.

These effects are robust for industry specific effects which we take into account by including a full set of sector dummies. Nevertheless, as column (2) shows, the differences between entrants and incumbents are much more pronounced in sectors with high (i.e. above average) concentration. In these high concentration sectors, incumbency gives a greater advantage in terms of production share, but incumbents are less effectively using technological leadership to build their production leadership. In fact, the size of the interaction effect suggests that the effect of technological leadership is no longer present for incumbent MSM firms in high concentration sectors. For new entrants in high concentration sectors, in contrast, technological leadership impacts strongly on production leadership.

The results are also significantly different for sectors that are sensitive to single market reform (SMP sensitive).[16] In SMP sensitive sectors, incumbent MSM firms have a slightly lower advantage in terms of production share. Although also here incumbents are less effectively using technological leadership for production leadership as compared to new MSM firms, the interaction effect is smaller and incumbents' technological leadership still has a sizeable impact on production leadership. Hence, in SMP sensitive sectors technology positions are more important for product leadership, both for incumbents and entrants. For high and medium tech sectors, similar results are obtained. In these sectors, incumbency gives a lower advantage in terms of production share, and incumbents are less effectively leveraging technological leadership into production leadership as compared to new MSM firms. But nevertheless, for both types of firms in high and medium tech sectors, technology strength is a significant force for production leadership.

In Table 7.11 we include other characteristics of the technology and product positions of firms. First, it is important to observe that the relationship between technology and market leadership remains robust when including other firm characteristics. For technology specialization, we include the Herfindahl measure, the inverse of the technology

[16] See Annex 5 for the definition of single market sensitive sectors.

diversification index, (see section 3.3.5). The negative sign indicates that MSM firms with broader technology portfolios are able to secure stronger market leadership positions. Interestingly, this effect is only obtained when also controlling simultaneously for the product market specialization of the firm. MSM firms that are more specialized in core production activities have a significantly *higher* production share in their industry. It thus seems that the more successful MSM firms (in terms of production share of their sector) are combining a strategy of market focus with a broader technology portfolio strategy, while ensuring at the same time a deep technology position in the sector of dominance.[17] For extra-EU multinationality of technology and production activities, the results suggest that while a focus on EU production (not surprisingly) improves production leadership in the EU, a EU home bias in technology activities works negative on production shares. The latter suggests positive effects of R&D internationalization: firms that have a more globally oriented R&D strategy achieve a stronger product market dominance in the EU. While this effect is only marginally significant when including all firms, this effect becomes stronger and significant for the group of EU-based firms.

Table 7.11.

Determinants of the share of sectoral EU production, 2007

	(1) All Firms	(2) EU-based
EU technological leadership	**.952*** **	**1.091*** **
Presence in Top 5, 2000 (Incumbency)	.038***	.050***
Interaction	-.76***	-.919***
Technology Specialization (Herfindahl)	-0.055**	-0.039
Product Focus (Herfindahl)	0.041**	0.076***
Share of EU in firm patents	-0.03°	-0.05*
Share of production in EU	.051*	.014
EU-based	n.s.	
(N, StatSign of F-test, Adjusted R²)	*245,***, .45*	*169,***, .46*

Note: Industry Dummies Included;

Method: OLS, ***=1% significance; **=5%, *=10%,° =15%

[17] The correlation between technology and product diversification is illustrated by the following statistics: MSM firms with above average diversified Product activities (i.e. a Production Herfindahl index below average) are patenting on average in 14 sectors, while MSM firms with above average concentration of Product activities are patenting on average in 9 sectors.

For EU-based leading firms, not only is a larger geographical dispersion of technology activities more important for securing market leadership in the EU, a stronger product focus also matters. The technology breadth dimension does not seem to vary enough within this subsample of firms to make a significant difference. The importance of technological strength holds even more for EU based new firms than for non-EU based.

Determinants of Technological leadership

Analysing the determinants of technological leadership is more difficult with the MSM data. When taking the 2007 technological leadership position (which reflects patent data for 2004-2006) as dependent variable, we have to use prior production data to examine the potential effect of product leadership. This requires the use of production information in 2000. This limits our analysis to incumbent MSM firms, as we only have 2000 data available for this group. This is a smaller and selective subsample. The results therefore need to be handled with extra care. The (non-tabulated) results appear to support a positive correlation as MSM firms with higher shares of sectoral EU production in 2000 have significantly greater EU technological leadership in 2007 (the coefficient is .326***). This effect holds even when correcting for other industry specific effects and firm characteristics. Most of the other firm characteristics are not significant however. Marginally significant (at 10% level) is the effect of technology diversification, suggesting a positive correlation between technology breadth and technological leadership.

Changes in Market Leadership through new entries

To uncover the factors that may help or hinder the building of new market leadership positions (changes in market leadership), we compare new versus incumbent MSM leading firms in a multivariate analysis. More concretely, we perform a Probit analysis on the likelihood to be a new leading firms versus an incumbent firm. We are particularly interested to see how important a strong and/or a broad technology portfolio is for obtaining new market leadership positions.

Table 7.12

Determinants of the probability of being an Incumbent MSM firm

	All Sectors
EU technological leadership	**2.78**
Technology specialization (Herfindahl), 2007	-1.13***
Share of EU in firm patents	n.s.
EU-based	0.718***
High-Concentration Sector	0.618***
High-Tech Sector	n.s.
Low-Tech Sector	-0.441**
SMP Sensitive Sector	n.s.
Sutton Type 2 Sector	n.s.
(N, StatSign of Chisq-test, Pseudo R^2)	*254,***, .123*

Note: Dependent variable is a dummy variable, which takes the value of 1 for MSM firms that already had a Top 5 position in the MSM sectors in 2000.

Method: Probit, ***=1% significance; **=5%, *=10%

See Annex 5 for definitions of SMP sensitive and Sutton Type 2 sectors.

A number of interesting results emerge from Table 7.12. A strong technology position in the sector is not a significant determining factor separating incumbent from new leading firms: the coefficient is positive but not significant. When looking only at high and medium tech sectors (results not reported), technology strength similarly has no significant relationship with entry, a result that echoes the findings in Table 7.8. However, the results do strongly support the use of a broader technology portfolio associated with new MSM entrants, as indicated by the negative effect of technology specialization. These results hold even when controlling for sector characteristics. The results on sector characteristics confirm that there is more likely to be new MSM entry (less stability) in low-tech sectors and more stability in high-concentration sectors.

8. Pilot Studies of Service Sectors

In this section we will present first results of the application of the production matrix and technological leadership exercise to three service sectors: IT services, Telecommunication services and Food retailing. Our pilot tests showed that these service sectors have in common that the services delivered are quite well delineated such that leading firms can be identified and the value of their activity in the sector determined with reasonable precision. At the same time, our tests showed that for another potential service sector, business services, application of the MSM methodology is not possible. This sector, of which the Nace sector classification is 'other business activities', covers an extremely wide diverse range of services including accountancy services, engineering services, legal consultancy and law firms, architects, cleaning services, and personnel placement recruitment. This renders a market leadership exercise without much meaning as it would end up comparing leading firms from different segments. Since the service sector is a primer in this report, there is no comparison possible for the matrix of 2000.[18] Patent data for the leading firm will be presented for two periods, 1998-2000 and 1994-1996.

8.1 ICT services

ICT, Information and Communication Technologies, typically includes all those instruments and tools which enable information to be converted, stored, processed, transmitted and securely retrieved. Information technology (IT), as defined by the Information Technology Association of America (ITAA), is "the study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware." The sector is therefore the sum of hardware manufacturing activities– mainly computers – and of services, and can be described as the sum of all those activities linked to the development of software and customized applications and tools to enable companies in any sector to increase efficiency. Although the ICT sector includes both hardware manufacturing and services, the sector is experiencing a shift towards services: many traditional hardware firms (as IBM) are now completely or almost completely focused on software development and other IT-related services.

[18] Only IBM was included in the 2000 matrix, as a hardware producer in the sector "Computer and Office equipment".

Major players

A first exercise is the identification of the main players in the IT services sector from a worldwide perspective. Table 8.1 below shows the top 8 players in the world ranked through the values of their world sales in the ICT sector. The column on the left identifies the top 5 EU players, ranked by EU sales in the IT services sector.

Table 8.1: World Sales and EU sales in IT services for the world top 8 companies

European TOP 5	*Company Name*	*Nationality*	*World Sales in IT services (million €)*	*As a % of total world sales*	*EU Sales in IT services (million €)*	*% EU sales/World Sales*
1	IBM	USA	56.686	78	19.262	34
	Microsoft	USA	22.973	45	715	3
3	Oracle	USA	10.557	79	2.568	24
2	SAP	Germany	7.427	72	3.262	44
4	Sun Microsystems	USA	6.423	63	1.821	28
5	CA	USA	2.174	91	753	32
	Novell	USA	670	98	449	35
	Corel	USA	167	91	48	67

SAP is the only EU firm in the list, which is dominated by US firms. This shows the relative weakness of European industry in the sector. IBM is by far the largest player. The top 5 market leaders in the EU are identical to the top 5 firms in the world, with the exception of Microsoft. Although Microsoft is an important software seller, its IT services activities in Europe are limited and most software is sold directly to hardware-producing companies, which normally do not locate production in the EU.

The first player in the IT services sector is IBM. This company, which was one of the first to develop PCs, has shifted towards the development of software and services for business. IBM has 386,558 employees worldwide and total sales worth 72.348 million Euros in 2007, of which 56.687 in the MSM sector “IT services”. IBM was present in the MSM matrix study also in 2000, but back then it was listed in the top 5 of the sector “Computer and Office equipment”, because it was active in the computer manufacturing business. If we look at the diversification of IBM’s activities, we notice that most of IBM’s activities are performed in the IT services sector. Looking at table 8.2, we see that IBM has definitely given up all its hardware activities to focus on IT services (78%), business services (18%) and other types of activities (4%). Data for 2000 shows that, although services were already predominant, the hardware business was still strong: IT services covered only 51% of the turnover, while hardware made up for 42%.

Table 8.2: IBM activities subdivision

2007	IT services	Value	56.686
		%	78
	Hardware	Value	0
		%	0
	Business Services	Value	13.213
		%	18
	Other activities	Value	2.449
		%	4
2000	IT services	Value	49.088
		%	51
	Hardware	Value	40.570
		%	42
	Business Services	Value	1.469
		%	2
	Other activities	Value	3.755
		%	4

IBM's horizontal diversification in quite low, as can be said for all other ICT companies: IBM is active mainly in the software business and IT consulting, which is basically focused on adapting the software developed centrally by the company to the different clients' needs. IBM's clients range from public administrations to large and small companies operating across a large set of industries.

The second player in the top five is SAP. SAP is the only European company that can be found in the top 5. With headquarters in Germany and 43.800 employees in more than 50 countries, it can easily be considered as a multinational company. SAP generates sales of 10.242 million Euros, mainly in EU 27 and USA. As 76% of SAP turnover is generated through IT services and customized software, we can safely conclude that its diversification is low. There is a clear focus on providing IT solutions (software and services, mainly consulting and training) to companies. This is not uncommon in the IT sector. Many companies active in IT services are often not active in any other type of business, except related activities, such as business services, that are still related to the main field of expertise. SAP also provides training and consulting to the companies, predominantly in the field of IT.

The third player in the top 5 is US-based Oracle. Oracle is the world's largest enterprise software company, as stated in its Annual Report in 2007. The company is mainly active in developing databases and middleware software for enterprises, belonging to many different sectors. In 2007 Oracle's revenues were 13.335 million Euros and it employed 74.674 people all around the world. The company is divided into two main business units: "Software" and "Services". Analyzing more in depth the numbers referring to the company's diversification, we can see that 79% of the company's turnover is generated by the software business, while only 21% by services. This is once again an illustration of the low diversification in the IT services sector.

US-based Sun Microsystems[19] occupies the 4th position. It is a company that operates in over 100 countries and in 2007 generated revenues for 10.160 million Euros, with 34.200 employees and investments in R&D of 1.470 million Euros. The company is mainly active in the IT business of network computing services and products. The "products" division offers access to remote servers, storage, open source software and tools for business. In the case of Sun, the IT activities are not as predominant with respect to other services activities as it was for other companies, but still make 63% of the company's turnover, with business services taking 37%. It is important once again to underline that also in this case the other services offered by Sun are very strongly connected with the core "products" offered by the company.

The fifth and last player is Computer Associates. CA is a US company that describes itself as the "world's largest independent provider of information technology (IT) management software". The company pursues a strategy oriented towards developing software that can operate on a wide range of hardware platform and operating systems. It develops instruments for business that can be standardized in most aspects, and then customized for specific users, located across the world. The total volume of CA sales in 2007 was 2.888 Euros, of which 91% belongs to the IT services sector.

Multinationality

The IT services sector is a heavily globalised sector. As shown in Table 8.3 SAP, Oracle and Sun Microsystems are active in all 5 world regions, IBM is active in four out of five regions, and only CA is focusing on North America and Europe.

[19] Sun was recently acquired by Oracle, but was an independent firm in 2007.

Table 8.3: Sales per Region in IT services sector (in million €)

		EU27	*Rest of Europe*	*North America*	*Asia Pacific*	*Rest of the World*	*Total World*
IBM	Value	19.262	1.145	24.375	11.904	0	56.686
	%	34	2	43	21	0	100
SAP	Value	3.262	515	1.962	925	762	7.427
	%	44	7	26	12	10	100
ORACLE	Value	2.568	254	4.912	1.466	1.356	10.557
	%	24	2	47	14	13	100
SUN MICRO SYSTEMS	Value	1.821	187	2.612	563	1.239	6.423
	%	28	3	41	9	19	100
COMPUTER ASSOCIATES	Value	753	0	1.420	0	0	2.174
	%	35	0	65	0	0	100

IBM is active mainly in North America (43%) and Europe (34%) but also with a strong component in Asia-Pacific.. SAP is, like IBM, mainly active in Europe and US. Comparing IBM and SAP, confirms the importance of a strong home position in combination with substantial cross-Atlantic internationalization. Oracle is active mainly in its home market, the US, where it generates 47% of its turnover. EU-27 comes in second place, where 24% of its sales are realized. The same can be said for Sun Microsystems: EU 27 account for 28% of total sales in the MSM sector, while North America accounts for 41%. Sun is quite active in the Rest of the World region, where 19% of the turnover is generated. CA is active only in North America and the EU, where 65% and 35% of its sales are generated. Four out of five companies sell more than 40% of their services in North America, which is still the most relevant area for IT services.

Table 8.4 reports the multinationality inside the EU.

Table 8.4: Percentage of sales per EU country in IT services

Country	*IBM*	*SAP*	*ORACLE*	*SUN MICROSYSTEMS*	*COMPUTER ASSOCIATES*
	%	%	%	%	%
Austria	2	3	2	0	0
Belgium/ Luxemburg	4	2	3	4	12
Denmark	2	2	2	1	4
Finland	1	1	2	1	4
France	6	18	14	14	4
Germany	7	45	15	25	12
Greece	1	0,004	2	1	0
Ireland	18	1	2	0	0
Italy	6	4	2	8	4
The Netherlands	9	4	2	7	0
Portugal	3	1	2	0	0
Spain	4	3	2	7	20
Sweden	3	2	2	0	4
UK	26	9	24	29	36
Bulgaria	0,2	0,002	2	0	0
Cyprus	0	0,001	2	0	0
Czech Republic	1	2	2	2	0
Estonia	0,4	0	2	0	0
Hungary	1	1	2	0	0
Latvia	1	0	2	0	0
Lithuania	1	0	2	0	0
Malta	0	0	2	0	0
Poland	2	2	2	1	0
Romania	1	0	2	0	0
Slovakia	1	0,005	2	0	0
Slovenia	1	0	2	0	0
TOTAL	100	100	100	100	100

Among European countries, IBM is very strong in English-speaking countries (44%) and in the larger countries, Germany (7%), France (6%) and Italy (6%). Although IBM is active all over Europe, its activities are concentrated in a few countries, were it develops and sells most of the software produced, while it keeps a foot in each of the other European countries. SAP displays a similar profile, the most important EU country in terms of sales is Germany, its country of origin (45% of EU27 sales), followed by France (18%), UK (9%), Italy (4%) and the Netherlands (4%). The UK, Germany and France are also the three main markets for Oracle, totalling all together 53% of total European sales. For Sun Microsystems, this is 68%. However, both companies are active in most of the other European countries. CA sales concentrate in slightly different countries: the most important are UK (36% of EU sales), Spain (20%), Belgium and Germany (12% each).

We can evaluate multinationality through the calculation of the index based on the number equivalent of the Herfindahl index (see the methods section 2), both at the global and at the European level. The results are shown in table 8.5.

Table 8.5: Summary of Multinationality Indicators

Multinationality	*IBM*	*SAP*	*ORACLE*	*SUN MICROSYSTEMS*	*COMPUTER ASSOCIATES*
Global	2,90	3,41	3,20	3,43	1,83
EU	7,96	4,04	7,03	5,42	4,84

The values associated with the multinationality indices show that these companies are substantially global in scope, with diversification at the global level ranging from roughly 2 to a high of 3.4, with 5 being the maximum score possible. Global activities of SAP are more geographically dispersed than IBM's activities. In contrast IBM has a greater spread of its EU activities (EU multinationality of 7,9). Oracle and Sun Microsystems are close to SAP for global multinationality and have greater EU multinationality.CA has much lower values than average with respect to global multinationality, reflecting a stronger home bias compared to other US companies. However, it still has a high value of EU multinationality, showing a spread of its activities over different EU countries.

Technology positions

This section looks at the technological position of the firms measured by EPO patent applications around 2000 and 2007: patents are examined for the years 1998-2000 and 1994-1996. Table 8.6 summarizes the global spread of patents for the top 5 companies.

Table 8.6: Patents in the World by Region

		Share EU 27 (%)	*Rest of Europe*	*North America*	*Asia Pacific*	*ROW*	*Global Technology Multinationality*
IBM	2000	37	59	435	40	1	2,46
	2007	29	34	439	56	2	2,30
SAP	2000	60	0	9	0	0	1,92
	2007	78	4	68	49	1	1,59
ORACLE	2000	12	0	29	0	0	1,30
	2007	4	0	53	1	0	1,11
SUN MICRO SYSTEMS	2000	14	2	698	5	0	1,33
	2007	15	2	121	4	0	1,5
CA	2000	3	0	49	9	0	1,45
	2007	3	1	114	24	0	1,52

IBM is the most techno-global company of all companies in the ICT sector and has the widest spread of its technological activities. Its global multinationality index was 2.46 in 2007, up from 2,30 in 2000. Of all IBM's patents 29 per cent came from inventors based in EU27. This percentage is somewhat lower than the sales of the company in EU27 (34%) but is by far the highest for all non-EU companies in this sector. For SAP 78 per cent of all patents were invented in the EU in 2007: a strong home country focus. If we look at the total number of patents filed, the strong increase in applications between 2000 and 2007 is remarkable, and supports the strong technology position the company has been able to acquire in the ICT services sector.

Oracle has a narrower technological basis than IBM and SAP and a much smaller number of patents to support the strong sales position of the company in the world and the EU. It has a very small percentage of patenting activity in Europe, which has been decreasing since 2000. For Oracle, only 3% of patenting is of EU origin. Both Sun and Oracle have far less technology activities in the EU compared with their services sales. The EU in this sector cannot be seen as a location for technology sourcing.

Table 8.7 shows in more detail the location of technology activities across EU countries. Among the EU27 countries, the larger countries in which IBM patents are UK, Germany and France: they account for close to 90% of all patents. The strong position of the UK corresponds to the strong market position of the company in the country. For the same reason, one would expect Ireland to hold a strong position, but this is not the case. IBM has the greatest spread of EU technological activities: the EU multinationality index increased to almost 4 in 2007. SAP depends very strongly on its German base for technological developments. Only France holds an additional significant position as location of invention in the EU27 (9%) in 2007. Oracle and CA have only a handful of patents invented in the EU such that the EU country shares are not very meaningful. For Sun the UK and France are the countries in which they locate most technology activities. It has a similar spread over EU countries as IBM, with an EU multinationality index close to 3 in 2007.

Table 8.7: Percentage of patents by EU27 country in 2000 and in 2007 and EU technology Multinationality

Country	*IBM*		*SAP*		*ORACLE*		*SUN MICROSYSTEMS*		*COMPUTER ASSOCIATES*	
	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007
Austria	0,2	0,1		0,1						
Belgium/ Luxemburg		1		0,2						
Denmark	0,3						0			
Finland	0,1			0,5				4		
France	17	18		9	23		25	35		47
Germany	23	18	100	88	12		39	15		
Ireland		0,7					4			
Italy	1	7		0,1		50				
The Netherlands	0,03			0,9			5	2		
Spain	1	2					1			
Sweden	0,1	0,6			23			3		
UK	57	52		0,3	42	50	27	41	100	53
Bulgaria				0,7						
Czech Republic	0,3									
Hungary				0,005						
	100	100	100	100	100	100	100	100	100	100
EU Technology Multinationality	2,48	2,91	1	1,28	3,35	2	3,46	3,14	1	1,99

Table 8.8 summarizes the percentage of patents per company in each of the technology fields in which companies have patented most in 2000 and in 2007. IBM is the company with the greatest spread across technological fields, while SAP, Oracle and Computer Associates tend to focus all their patenting activities in two technology classes only. Both in 2000 and in 2007 most of the patenting activity concentrated in sector 4 of the Fraunhofer classification, “Information technology”. In 2000 it accounted for 62% of the total patenting activity of the top 5 companies, and in 2007 it accounted for 68%. The second technology class was “Telecommunication”, with 19% of total patents in 2000 and 15% in 2007.

Table 8.8: Percentage of patents of ICT top 5 companies by technology field

	IBM		SAP		ORACLE		SUN MICROSYSTEMS		COMPUTER ASSOCIATES		TOTAL	
SECTOR	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007
1 - Electrical machinery and apparatus, electrical energy	4	3	0	0	0	0	2	3	0	0	2	1
2 - Audio-visual technology	5	2	0	0	0	0	3	1	0	0	4	1
3 - Telecommunications	16	19	10	9	18	7	23	17	16	21	19	15
4 - Information Technology	51	49	88	88	82	91	69	71	84	78	62	68
5 -Semiconductors	17	22	0	0	0	0	1	6	0	0	9	10
6 - Optics	3	2	0	0	0	0	0	0	0	0	1	1
7 - Analysis, measurement and control technology	5	3	2	3	0	2	2	3	0	1	3	3
TOTAL NUMBER OF PATENTS	809	728	21	543	34	55	806	151	60	143	1730	1620
Number of Active Fields	26	18	5	6	2	4	12	7	2	3	9,4	7,6
Technology Diversification	3,40	3,22	1,47	1,31	1,41	1,25	1,93	1,88	1,36	1,53	1,91	1,83

8.2 Telecommunication services

Telecommunication is defined as "the assisted transmission over a distance for the purpose of communication". Telecoms are important because they are – as a part of the broader ICT sector – a driver of efficiency in many industries. In this section we will apply the MSM methodology to this services sector.

Major players

Table 8.9 shows the global and EU leaders in 2007. Although two US companies lead the top 8, five out of the 8 companies are European, showing a relative strength of EU firms globally. If we look at the EU sales in the services sector as a percentage of the world sales in the telecom sector we see that EU firms have a strong concentration of activities in the EU (as France Télécom/Orange, Vodafone and BT) while the non-EU firms have very small operations in the EU (AT&T, Verizon and Nippon Telegraph and Telephone). Two firms (Deutsche Telecom and Telefónica) rely less on EU sales, but the EU share is still more than 50%. We can conclude that the market is highly segmented, with local firms dominating their local market. If we analyze the top 5 EU firms, we see that the leading firms in Europe are all EU-based. The telecom services firms are clearly focused on the telecom sector, with non-telecom sales share close to zero.

Table 8.9: World Sales and EU sales in Telecom services for the world top 8 companies

Top 5	*Company Name*	*Nationality*	*World Sales in Telecom*	*As a percentage of total world sales*	*EU Sales in Telecom Services*	*As a percentage of world sales in Telecom*
	AT&T	USA	78.640	90	0	0
	Verizon Communications	USA	65.031	95	2.579	4
2	Deutche Telecom	Germany	62.093	99	46.539	75
	Nippon Telegraph and Telephone	Japan	59.531	89	357	1
4	Telefónica	Spain	56.441	100	35.357	63
1	France Télécom/Orange	France	52.959	100	47.826	90
3	Vodafone	UK	45.614	100	38.272	84
5	British Telecom	UK	29.657	100	28.426	96

The largest EU player is France Télécom/Orange. The company is based in France and is a provider of a wide variety of telecommunication services, from ADSL broadband and internet to mobile communication, IP telephony and ADSL TV. It is active in all the major submarkets, from home telecom, to mobile and business telecom solutions. In 2007 the company had more than 170 million customers and revenues for 52.959 million Euros. France Télécom activities are all focused on the telecom services sector. Deutsche Telecom, based in Germany, has revenues for 62.516 million Euros, and operates around 37 million fixed network lines and more than 13 million broadband lines. It had 240.000 employees and 119 million mobile customers. 99% of its activities can be classified as telecom activities. The third major player is Vodafone. The UK based company provides voice and data communication services for both private consumers and enterprises and in 2007 it registered 200 million customers. All the activities of Vodafone are in the telecommunication sector.

Telefónica is the fourth major European player: The Spanish company is the world's largest integrated operator by customer accesses. In 2007 it had 228 million customer accesses and net revenues for 56.441 million Euros. It employed 248.000 people. Like most of the other top players in the sector, also Telefònica has activities only in the telecom sector. The fifth player is British Telecom (BT). It is a UK based provider of local, national and international telecommunication services, broadband internet products and services and converged fixed/mobile products and services. It has around 106.200 employees worldwide and in 2007 had revenues for 29.657 Euros. All of the company's activities are in telecom.

Multinationality

Table 8.10 summarizes the main multinationality indicators at global level for the top 5 European companies.

Table 8.10: Sales per Region in Telecom services sector (in million €)

		EU27	*Rest of Europe*	*North America*	*Asia Pacific*	*Rest of the World*	*Total World*
France Télécom/Orange	Value	47,826	811	0	0	4,322	52,959
	%	90	2	0	0	8	100
Deutche Telecom	Value	46,856	1,093	14,191	0	375	62,516
	%	75	2	22	0	1	100
Vodafone	Value	38,272	1,992	0	1,826	3,524	45,614
	%	84	4	0	4	8	100
Telefónica	Value	35,357	0	0	0	21,084	56,441
	%	63	0	0	0	37	100
British Telecom	Value	28,426	46	1,043	142	0	29,657
	%	96	0	4	0	0	100

France Télécom's activities are located mainly in the EU 27 countries (90%). The company is also active in Africa, where 8% of its revenues are generated (mainly former French colonies and French speaking African countries). Deutsche Telecom has the same home bias: the company has most of its activities in Europe (75%), while it keeps a quite strong foot in the US market (22 %). The EU is also a very important region for Vodafone's sales (84%). It is also active in Africa (Kenya, Egypt and South Africa), with 8% of total sales. Vodafone is not present in the North American market. As stated in its Annual Report, Vodafone tries to keep a strong position in its "traditional" markets and when it enters new markets it does so, only if it sees a growth opportunity, as in China (in 2007 limited to 0.8% of the company's sales). Telefónica's concentrates less of its sales in the EU27 (63%). The company shows the highest sales share among the top 5 in the 'rest of the world' category: 37% of the sales is generated in South American countries, and more specifically Spanish speaking countries. British Telecom, has the largest concentration of sales in the EU (96%). The only relevant activity in a foreign region is represented by the 4 % sales generated in the US.

Table 8.11 shows the localization of the activities of the top 5 companies within Europe. France Télécom is mostly active in France (60 %) followed by the UK (14 %) and Poland (10%). Germany is the main market for Deutsche Telecom totalling (66%), followed at a distance by the UK (14%).The company is active in some emerging EU markets (Poland, Hungary and Slovakia) but still modestly. Vodafone is active in 14 of the 27 European markets, showing a much more pronounced spread within the EU, although it tends to concentrate activities in a more limited number of countries: Germany (21%), UK (20 %), Spain (18%) and Italy (16%). Telefònica generates more than a half of its European revenues in Spain (59%), but is also active in the UK market (22 %). Telefònica is also active in Czech Republic, 6% of its sales are generated there. British Telecom, is active in Europe in a relatively large number of countries, but in these countries it has a small presence, based especially on smaller stakes in local companies which provide broadband access. Its core activities are all in the UK, where it generates 89% of its sales.

Table 8.11: Sales per EU country in Telecom services

Country	*France Télécom/Orange*	*Deutche Telecom*	*Vodafone*	*Telefónica*	*British Telecom*
	%	%	%	%	%
Austria		3			1
Belgium/ Luxemburg	3				
Denmark					0,03
Finland					0,03
France	60		2		2
Germany		66	21	10	4
Greece			3		
Ireland			3	3	2
Italy			16		1
The Netherlands		4	3		0,4
Portugal			3		
Spain	8		18	59	1
Sweden					0,03
UK	14	14	20	22	89
Czech Republic		3	2	6	0,3
Hungary		3	2		0,2
Malta			3		
Poland	10	6	2		0,05
Romania	3		2		
Slovakia	2	1			
TOTAL	100	100	100	100	100

Global and EU multinationality can also be assessed through the diversification index. Table 8.12 summarizes these measures for the top 5 companies.

Table 8.12: Summary of Multinationality Indicators

Multinationality	*France Télécom/Orange*	*Deutche Telecom*	*Vodafone*	*Telefónica*	*British Telecom*
Global	1,22	1,63	1,40	1,88	1,09
EU	2,49	2,19	6,87	2,44	1,26

Globally, the diversification index ranges from 1.22 (France Telecom) to 1.88 (Telefónica) against a maximum of 5 regions. These are modest numbers compared to the ICT sector. Vodafone is the clear leader in EU multinationality (6.87) while the index for the other firms are between 2- 2,5. BT is the exception with near zero spread (index close to 1) both on a global and EU level.

Technological position

This section looks at the technological position of the company measured by EPO patent applications in two selected years 2000 and 2007. As before, the position in the year 2000 refers to the patent applications made over the period 1998-2000. For the year 2007, the period 2004-2006 is used. Table 8.13 summarizes the main patent data for the top 5 companies.

Table 8.13: Number of patents in the World by Region

		Share EU 27 (%)	*Rest of Europe*	*North America*	*Asia Pacific*	*Rest of the World*	*Global Technology Multinationality*
France Télécom/ Orange	2000	98	1	5	0	1	1,04
	2007	96	1	16	4	0	1,07
Deutche Telecom	2000	97	1	5	1	3	1,07
	2007	97	0	3	2	0	1,06
Vodafone	2000	99	0	0	1	0	1,02
	2007	74	1	1	61	0	1,65
Telefónica	2000	100	0	0	0	0	1,00
	2007	100	0	0	0	0	1,00
British Telecom	2000	99	0	3	1	0	1,03
	2007	97	0	0	4	0	1,06

France Télécom derives less than 5 per cent of its patents from inventions outside the EU. The number of patents of the company has increased by 84% from 2000, to 587. Deutsche Telecom derives similarly less than 5 per cent of its patents from inventors outside the EU, but its patent applications declined. Among the leaders in the EU Telecom Services sector, Vodafone is the company with the strongest patenting activity outside the EU. The share of patents obtained through non-EU inventions is even higher than the share of sales the company realizes outside the EU (16%). Telefónica has the narrowest technological base. In spite of its relatively strong presence in South America, the company has no patents originating from the region. BT also shows a decline in patent applications, while near all its activities are located in the EU.

Table 8.14 examines in more detail where companies locate technology activities within the EU. This table shows that patenting activity is generally subject to a very strong home bias. This is true for all the companies, starting with France Télécom, which concentrates its patenting in France. Only the UK accounts for some patents, but still less than 4 per cent of the total number of patents. Even stronger than is the case for France Telecom, Deutche Telecom concentrates its patenting exclusively in its home market, Germany. Vodafone's patenting activities reflects the higher multinationality of the company: the spread of patents across EU countries is higher than for the other leading companies in the sector and its EU multinationality index reached 2.65 in 2007. Germany, the UK and to some extent Spain are the main centres for patenting inventions. Telefónica had a very high home bias in 2000, when all its patents were generated in Spain. However, the patenting activity in 2007 was more dispersed across EU countries: the patents in that year were primarily obtained in Germany. British Telecom also has a strong concentration of patenting activity in its home market: Outside the UK, BT only has technology activity in Sweden to a meaningful extent.

Table 8.14: Percentage of patents by EU27 country in 2000 and in 2007

Country	*France Télécom/Orange*		*Deutche Telecom*		*Vodafone*		*Telefónica*		*British Telecom*	
	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007
Austria				0,6						1
Belgium/ Luxemburg	0,9	0,1			1	1				
France	93	96				2			0,28	0,29
Germany			99	97	95	55		67	1	0,29
Greece										1
Ireland			0,1			1				
Italy		0,1	0,1			1				1
The Netherlands	0,97	0,1	0,2	0,9		6			0,1	1
Spain						11	100	30		1
Sweden					1	1		3	4	3
UK	5	4		1,3	2	24			94	93
Czech Republic			0,1							
Poland	1									
TOTAL	310	566	248	155	81	177	16	10	292	172
	100	100	100	100	100	100	100	10	100	100
EU Technology Multinationality	1,16	1,09	1,01	1,06	1,11	2,65	1	1,87	1,12	1,16

Table 8.15 summarizes the percentage of patents per company in each of the technology fields in which companies patented in 2000 and in 2007. All companies patent most in sector 3 and 4 (telecommunications and information technology), which is similar to the ICT service sector patenting pattern. For France Telecom, the relative share of patents in sector 3 and 4 increased while decreased to near zero level in sectors 5 and 6 (semiconductors and optics), which used to be important patenting sectors. Its technology diversification index reduced accordingly from 3,99 to 2,17. Vodafone also has more focused technology activities in 2007 with an increased specialization in sectors 3 and 4. The technology diversification index more than halved to around 2 in 2007. BT's focus on the two main technology classes remained stable. Telefónica, the weakest company in the group by patenting activity, has maintained its concentration of activities in the telecommunications field, beside minor activities in control technologies. Diversification marginally increased for BT, due to a greater spread between IT and telecoms.

Table 8.15: Percentage of patents by the leading firms by technology class

	France Telecom/Orange		Deutche Telecom		Vodafone		Telefónica		British Telecom		TOTAL	
SECTOR	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007	2000	2007
1 - Electrical machinery and apparatus, electrical energy	2	1	2	0	10	0	2	0	0	1	2	1
2 - Audio-visual technology	8	8	7	6	0	3	20	0	4	5	6	6
3 - Telecommunications	46	64	54	63	57	66	70	78	57	46	53	62
4 - Information Technology	14	23	11	19	2	24	6	11	32	40	18	25
5 – Semiconductors	19	0	0	0	0	0	0	0	0	0	6	0
6 – Optics	7	1	11	2	0	0	0	0	3	3	6	1
7 - Analysis, measurement and control technology	4	4	14	10	31	6	2	11	4	5	8	6
TOTAL NUMBER OF PATENTS	302	584	246	155	59	239	16	9	280	169	903	1156
Technology Diversification	3,99	2,17	3,15	2,35	4,80	2,01	1,85	1,92	2,61	2,93	3,28	2,28
Number of Active Fields	5	16	2	17	14	6	5	4	13	11	7,8	10,8

8.3 Pilot study of Food Retail services

A final pilot study was conducted for the food retailing industry. This is a relatively homogeneous sector, with the large players competing across Europe with similar strategies. These main players are supermarket chains and general merchandise retailers. Leader identification proved well possible. On the other hand, calculations of firm's diversification proved to be very difficult. Supermarket chains do not report detailed numbers of sales by product category, and reliable sales figures can only be obtained at a more aggregate level, including non-food retailing. This may be a more general difficulty in service industries: a lack of tradition in reporting, leading to a difficult distinction and delineation of specific services. In case of food retailing, this necessitates broadening the industry definition to general merchandise retail, in order to maintain consistency.

Major players

A list of the top 8 world player in the sector is provided in Table 8.16, which also summarizes the main sales data for the top five companies.

Table 8.16: World Sales and EU sales in Food Retail for the world top 8 companies

Top 5	*Company Name*	*Nationality*	*World Sales in Food Retail*	*EU Sales in MSM-sector*	*As a percentage of world sales is Food Retail*
	Wal-Mart	USA	271.177	7.418	2
1	Carrefour	France	81.459	72.710	89
2	Tesco Plc	UK	68.144	59.514	87
3	Metro Group	Germany	64.337	56.398	88
	Home Depot	USA	56.127	0	0
	Cardinal Health	USA	54.178	500	1
	Kroger	USA	51.796	0	0
4	Schwarz Group[20]	Germany	50.000	50.000	100
5	Rewe Group	Germany	45.060	43.703	97

EU market leader is Carrefour of France, followed by Metro of Germany and Tesco of the UK. The German Schwarz (Lidl) and Rewe groups complete the group of 5 EU leaders. All five top EU companies are European by origin and three of them are German. These companies have a strong EU bias in operations, with EU sales share in the range of 87-97

[20] Schwarz Group is a private company and therefore it was impossible to retrieve detailed information on the diversification and intra-EU geographical spread of the company. For this reason it is only partly included in the analysis.

percent. The US firms, and in particular world leader Wal-Mart fall out the top five in the EU because they do not operate a substantial number of stores in the EU.

Multinationality

Analyzing the top 5 in more detail, we see that all companies concentrate activities in Europe.

Table 8.17: Sales per Region in Food Retail sector (in million €)

		EU27	*Rest of Europe*	*North America*	*Asia Pacific*	*Rest of the World*	*Total World*
Carrefour	Value	66.966	1.462	0	5.480	8.211	82.143
	%	82	2	0	7	10	100
Tesco Plc	Value	59.514	630	8.000	0	0	68.144
	%	87	1	12	0	0	100
Metro Group	Value	56.398	3.100	0	1.591	1.248	81.459
	%	88	5	0	2	5	100
Schwarz Group	Value	50.000	0	0	0	0	50.000
	%	100	0	0	0	0	100
Rewe Group	Value	43.703	1.175	0	0	182	45.060
	%	97	3	0	0	0	100

Carrefour has a good spread over different regions: it has activities in the Asia-Pacific region (7%) and in the rest of the World (10%), but not in the US. Metro is also present in Asia (2%) and in the rest of the world (5%). Tesco is present in North America, where it reaches 12% of its sales, while Schwarz Group is an almost fully European-focused company, similar to Rewe Group.

Table 8.18 contains the main information on the localization of sales in the EU.

Table 8.18: Sales per EU country in Food Retail

Country	*Carrefour*	*Tesco Plc*	*Metro Group*	*Rewe Group*
	%	%	%	%
Austria			3	11
Belgium/ Luxemburg	6		3	
Denmark			0,4	
France	56		7	3
Germany			47	73
Greece	4		1	
Ireland		5		
Italy	10		7	4
The Netherlands			4	
Portugal	1		1	
Spain	20		6	
Sweden			0,2	
UK		84	3	
Bulgaria			0,8	
Czech Republic		2	3	2
Hungary		3	2	1
Poland	2	4	8	2
Romania	1		3	3
Slovakia		2	0,7	1
TOTAL	100	100	100	100

Most of the activities concentrate in EU 15 countries, and only smaller shares of sales is derived from accession countries. Carrefour focuses its activities in three major markets: France (56%), Spain (20%) and Italy (10%). The strong home bias is clearly visible, as more than half of the sales are realized in the home country. This is even more visible if we look at Tesco's data. The UK-based company realizes 84% of its sales in the home market. However, Tesco also has 11% of its activities located in the Czech Republic, Hungary, Poland and Slovakia. Metro is the strongest player in accessing countries: it records more than 16% of its sales outside the EU15. However, like its competitors it shows a home bias, as 47% of its activities are located in Germany. Rewe Group concentrates sales in Germany: 73% with much of the remainder in Austria (11%).

To assess more precisely the multinationality of the top 5 companies, Table 8.19 summarizes the multinationality indices. Values for multinationality are low, with global multinationality only above 2 for the Metro group. EU multinationality is also high for Metro, followed by Carrefour.

Table 8.19: Summary of Multinationality Indicators

Multinationality	*Carrefour*	*Tesco Plc*	*Metro Group*	*Rewe Group*
Global	1,47	1,29	2,08	1,06
EU	2,71	1,39	4,08	1,85

Technological position

In terms of technological positions, the results show that patent statistics are not very informative about technological leadership. None of the leading firms had any substantial patent applications in the considered periods; In the 2000-2006 period, Carrefour and Tesco applied for 1 EPO patent, while Metro applied for 2. Schwarz and Rewe have no patent holdings. Also in the IPTS R&D scoreboard, only Metro and Tesco appear with R&D expenditures, for each firm representing less than 0.5% of total sales. This is related to the low technology intensity of the sector. Firms may use (IT) technologies developed elsewhere but are not actively involved in inventive R&D activities themselves.

8.4 Overall Conclusions on Case Studies

The service case studies showed some interesting contrasts. In *ICT services*, the leading firms are globalised, and spread activities in various regions of the world. Most top firms are of US origin, with only German-based SAP the exception. The EU is an important market for the US firms and US firms have distributed activities in a range of EU countries. The firms in the ICT sector are rather specialized and non-diversified. When they are active in other (services) sectors. these sectors are typically very related operations in business services or consultancy. Strikingly, none of the firms is involved in hardware production: Both IBM and SUN had completely abandoned these activities by 2007.

There is an increasing importance of patenting for ICT service firms, and patenting shows a strong growth. The leading firms slowly converge in the intensity of patent activity. Previous hardware firms, on the other hand, see a decline in patenting associated with the exit from hardware activities, since the latter activities are generally more patent intensive. In terms of the location of technology (patenting) activities, only IBM can really be considered broad in geographic scope. The other three US-based companies show a strong concentration of their patenting activities at home and little activity in the EU. Hence, the EU in this sector cannot be seen as a location for technology sourcing, although it is an important market for

US firms. Within the EU, the larger EU countries: France, Germany and the UK hold a very dominant position. Overall, the pattern of technology activities shows an important degree of concentration and little internationalization. US firms, with the exception of IBM, have a strong concentration of technology activities in the home country and conduct little patentable R&D in the EU. For SAP this concentration is less pronounced, as it is also active in the US. Hence, it is clear that the EU is not a major technology hub and does not attract technology sourcing R&D activities.

In contrast with the ICT service sector, the *telecom services* sector has internationally fragmented markets. The main players are much less global and focus only on selected foreign markets. US firms dominate US markets and EU based firms dominate EU markets. The EU firms have moderate global activities but in most cases in less developed economies, and less so in the US. There is some expansion in new member states. Vodafone has the broadest dispersion of EU activities. Diversification levels are, as in the ICT services sector, low. In terms of technology, a wider spread of activities over technology classes declined over time, with a strong concentration in telecommunication and information technology in 2007. As in the ICT services sector, there is an increasing importance of technology (patent) development in some leading firms. The EU firms that are leading the EU sector maintain a strong focus on the EU as location of technological activities. The most common trend is a reduced diversification in technology activities with a focus on telecommunication technologies, and IT as secondary category. Technological activities are more concentrated in the EU than sales, and EU multinationality also tends to be low.

In *food retailing* there is a mix of moderately internationalized players from the EU and local EU players. EU retailers are relatively strong, in particular in their home markets in the EU, and world leader Wal-Mart is near absent in the EU. Although internationalized, the EU multinational retailers' foreign activities still relatively limited compared to their EU sales. Within the EU there is a broader spread over EU countries, but the home EU home market of the firms stay important. A number of firms, in particular Metro, increased activities in accession countries. The leading firms are not diversified once the retailing of other products than food is taken into consideration. Since most firms are general merchandisers operating chains that also sell non-food items, disaggregate information on food sales is not available, and the sector definition in practice had to be expanded to general merchandise retailing Patent data in this sector do not inform much about technological leadership with only 3 out of 5 firms with 1 or 2 patent applications.

Application of MSM to Services sectors

The pilot cases of service industries showed that the MSM matrix exercise in many aspects could be extended to services industries. The following caveats which arose during the case analyses should be kept in mind.

- Some service sectors are too heterogeneous to conduct leadership analysis (e.g. business services). On the other hand, it would be possible to trace leaders is more narrowly defined subsectors (architects, cleaning companies, etc). The MSM exercise in services would have to redefine the sector classification in a more detailed manner, but this is not that different from what happened in the MSM sector definitions for manufacturing (such as the detailed analysis of the food sector). In some other cases, however, such as the retailing sector, further disaggregation may often not be possible, as was the case for food retailing.
- Diversification indicators in services are often difficult to establish because no established benchmark of disaggregated subsectors similar to manufacturing exists. Furthermore, there often is no detailed reporting by sub-activity in service firms.
- It is sometime difficult to establish where the services are in fact 'produced': the distribution or production often is not easily disentangled from the location of sales. If this is possible, however, such as in the case of Microsoft, it can have mayor implications for the selection of EU leaders.
- Patenting is increasingly important in high technology services (ICT services, Telecommunications) such that it will be possible to extend the matrix to the technology dimension as well. On the other hand, in (many) other services, such as food retailing, patent data do not inform on technological leadership. This could be because R&D is low as in low tech manufacturing sectors, but also because services R&D less often leads to patenting, which is due to the greater difficulty establishing patents for services. In these cases, other types of appropriation strategies (lead time, complexity) are more likely to be used.
- Another complication to use patents information for technology positioning in service sectors is the absence of an existing concordance between service sectors and technology classes. In current concordances, service sectors are never considered as a sector where patents originate. Hence, sector-specific technological leadership cannot be assessed.

9. Conclusions

This study built further on results from a previously developed “EU Market Share Matrix (MSM) analyses. The MSM for the EU is a firm-level database covering production by location for all “leading firms” in EU manufacturing sectors. The EU market share matrix, although a very compact database, is nevertheless capable of generating estimates of various key structural variables: sectoral diversification, geographic diversification (multinationality) at the firm level, and producer concentration within industries. In this study we extended the MSM database to cover the year 2007 and make comparisons possible with the latest previous exercise of 2000. Second, we extended the matrix with a technology dimension: we complemented production data with data on the portfolio of patents in various technologies of all leading firms and the location of inventions. Third, we explored to what extent the MSM approach can be extended to the services sectors, through case studies of ICT related services, telecom services, and the food retailing sector. The main focus of this project was on the relationship between technology and market leadership in a context of increasing competition in an integrated internal market. The main *findings* are summarized below:

On *market leadership, diversification and multinationality*

- The 2007 matrix contains 250 firms, which together take up 305 leadership positions in 61 manufacturing sectors.
- There has been substantial change in the EU production leadership between 2000 and 2007 with on average 2 new leading firms per sector. Part of this turbulence in leadership positions is related to M&A activity. Turbulence is substantially smaller in high tech industries.
- Producer concentration (production share of the largest 5 firms in the EU) has further risen during 2000-2007 to 36 percent on average. This rise in concentration is to an important extent related to M&A activity and is accompanied by substantial turbulence in production leadership. Turbulence is lower in the industries with the highest concentration rates. The trend in concentration is not different for industries that were most sensitive to market integration in the EU.
- The global dimension of the matrix firms has increased. The presence of non-EU firms among the leaders increased to one third and new entry into the matrix is much more likely to come from non-EU firms than from EU-based firms. On average the leading firms have a growing global presence and within-EU spread of activities. The share of worldwide production of the leading firms that take place within the EU

declined to 58 percent**.** Multinationality levels on average are equivalent to an equal spread over two world regions (global multinationality) and three EU countries (EU multinationality).

- Product diversification has further declined during 2000-2007 with diversification equivalent to an equal spread over two sectors on average.
- Incumbent MSM firms manage to maintain a significantly higher production share as compared to new MSM firms,
- Turbulence in leadership positions and new entry is more likely in low tech sectors and sectors with low producer concentration levels.

On *technological leadership, diversification and multinationality*:

- Out of the 250 MSM firms, 209 firms hold EPO patents in 2007 (84%). The Leading firms hold 31 percent of total EPO patents invented in the EU.
- On average, an MSM firm holds 2% of EU located patents of its MSM sector. This share has increased over time, suggesting an increasingly important role of technology for production leadership.
- In high-concentration sectors and high-tech sectors, MSM firms are found to hold the strongest technological leadership positions, and to have increased this position of technological dominance more than firms in other sectors
- EU based leading firms conduct a larger share of R&D in the EU than the share of the EU in their global manufacturing in the sector, but this 'home bias' in R&D is however decreasing over time, especially in High-Tech sectors. Large technology firms have a smaller EU home bias compared to less patent active MSM firms. Non-EU based firms conduct a share of global R&D in Europe that is commensurate with their share of global production in the EU: hence, foreign firms' leadership positions are strongly associated with based on EU-based technological activities.
- Technology diversification on average is equivalent to an equal spread over 4 out of 30 main technology classes. Unlike product diversification, technology diversification is relatively stable over time. It is higher for firms in high-tech sectors and for non-EU based firms.

The MSM data and multivariate analysis provide strong support for a positive relationship between *technology and product market leadership*.

- Technology leading firms with higher shares of sectoral patents (a stronger EU technological leadership) have a significantly higher share of their sector's total EU production sectoral production as compared to non-technology leading MSM firms. This positive relationship remains highly significant and sizeable even when factoring in other sector or firm characteristics.

- Technological leadership is less important for incumbents to sustain their production leadership, as compared to entrants. For new entrants, in contrast, technological leadership is very important to build up a sizeable production share. Although on average entrants hold weaker technology positions compared to incumbents, this is not the case in high tech sectors. Those entrants that do manage to build a strong technology position are rewarded for this in terms of higher production shares.
- In highly concentrated sectors, new leading firm entry is less likely to occur, and incumbency gives a greater advantage in terms of production share. Technological leadership in these sectors has no effect on production leadership for incumbents. For those firms that succeed in obtaining new leading positions, in contrast, technological leadership is very important for building a stronger production leadership.
- In sectors characterized by a higher sensitivity to the Single Market and/or by a higher technology intensity, technology positions are more important for production leadership, both for incumbents and entrants. This suggests that increased competition in the wake of single market reforms may haves led to an increasing importance of R&D and innovation to maintain competitiveness.
- Firms that combine a strategy of product market focus with a broader technology portfolio can secure a stronger product leadership position.
- New entrants are broader in technology scope, suggesting that they leverage their technology position from other sectors to effectuate entry.
- In high tech sectors, and particularly for technology leading firms, there is an increasing trend of internationalization of R&D with firms locating R&D activities outside the EU. Among the leading firms, EU-based firms with a stronger global orientation in terms of the location of R&D achieve greater production dominance in the EU, indicating the possible importance and effectiveness of such global technology sourcing strategies for EU competitiveness.
- Incumbent leading firms that see their production share increasing over time are also more likely to increase their technology shares, confirming a positive link between technology and production leadership growth.

On *services sectors*

- In both the ICT services and Telecommunication industries, the technology dimension and patent holdings are of increasing importance. In ICT there is a convergence with software firms increasing patent activities, while previous hardware firms (IBM, Sun) accompany a shift toward services with a reduced patent intensity. For the only EU based ICT service leader SAP, a leading production position is related to the strongest increase in patent activity in the sector. In both ICT and telecommunication services there is an increasing concentration of patenting activity in core technologies, which are partly overlapping. Technological activities in the sector are mainly concentrated in the US. The EU is not an important location of US firms' R&D.
- Regarding the production dimension, the ICT services and telecommunication services sectors show important contrasts. While the ICT services sector is dominated by globally operating (US) firms, the EU telecommunication sector is dominated by EU firms, which derive most revenues from the EU and focus only on selected foreign markets and new member states in their expansion strategies. The technological activities of the firms show a similar focus on the EU.
- In the food retailing and general merchandise retailing sector, there is a mix of moderately internationalized players from the EU and local EU players. EU retailers are relatively strong, in particular in their home markets in the EU. Within the EU there is a broader spread over EU countries, but the home EU home market of the firms stay important. Patent data in this sector do not inform much about technological leadership.

Implications for EU policy

These findings suggest a number of *implications for EU policy*:

- Since technological strength and breadth are increasingly important for leading firms to build and sustain product market positions in the EU and this across all sectors, innovation policy instruments geared towards improving firms' technological strength and breadth, are rightly emphasized as an important component of the Lisbon Agenda for Growth and Jobs.
- Specific policy attention should be devoted to new leading firms. The analysis indicates that for firms to become a leader in the industry a broad, and especially a sufficiently deep technology portfolio in the targeted sector is important. This holds particularly for highly concentrated sectors. Consequently, barriers to build such broad and deep technology portfolios by firms should be eliminated as much as

possible. As these barriers might be structural, as well as strategically erected, this involves, beyond innovation policy instruments, also competition policy instruments.

- As the results highlight the positive correlation between production leadership and technological leadership, but also point out the more difficult entry of new leading firms in highly concentrated sectors, technology considerations should be more on the radar screen of competition authorities, when analyzing competition cases in these sectors. Competition policy authorities should particularly keep a close eye on whether dominant incumbent firms use their market and/or technology power to pre-empt the building of broad and deep technology portfolios, which are important for entry by new leading firms.
- The location of inventive activities is highly correlated with the location of production activities both for EU and non-EU firms. Policies aimed at increasing the attractiveness of EU product markets, are therefore an integral part of a policy aimed at making the EU more attractive for R&D activities.
- EU firms that exploit global technological expertise are also the companies that manage to maintain the strongest production activities in the EU. Hence, the trend that EU firms are locating R&D activities outside the EU should not be seen as a trend to be reversed by policy.
- The fragmentation in the services sectors studied (particularly in Telecom and Retail, but less in ICT services), suggests that the Single Market Program should be further strengthened particularly in these sectors.

Our study and analysis also brought out the most important *limitations* of the MSM methodology, which suggest directions for extensions and future approaches:

- The relationship between technology dimensions -measured through patent data- and production leadership is most relevant in medium and high tech sectors. There, analysis would benefit from including a larger group of leading (technology) firms. For other sectors, alternative measures of innovation and technology would be preferable. Innovation Surveys on broader innovation activities do provide such alternative measures. If such survey information could be combined with the production matrix data collected in this study, it would open up substantial opportunities for analysis of technology – market relationships across all sectors. Second, a possible extension of the matrix dataset in the future is to add firm level productivity estimations as an alternative, complementary measure of technology development and use.

- In a number of sectors, extra-EU offshoring of production is an important phenomenon, which leads to a change in production leadership (with smaller, often niche producers taking leadership positions) alongside a growing discrepancy with market leadership position of the offshoring firms. Future studies may identify EU market leaders as well as production leaders and the relationship between EU and global technological activities and strengths.
- Application of the MSM matrix to services sectors is possible but will face a number of difficulties. It requires prior work on establishing a more detailed classification of services product markets. Diversification indicators in services are often difficult to establish because no established benchmark of disaggregated subsectors similar to manufacturing exists. It is sometime difficult to establish where the services are in fact 'produced': the distribution or production often is not easily disentangled from the location of sales.
- Application of the methodology used for the technology dimension to services is more problematic. While patenting is increasingly important in high technology services (ICT services, Telecommunications), in many other services, such as food retailing, patent data do not inform on technological leadership. This is related to the difficulty establishing patents for services and the absence of an existing concordance between service sectors and technology classes.

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Annexes

Annex 1: MSM Industry Classification and NACE Concordance

MSM sector	Industry	Nace Rev. 1.1 (2002)
101	Manufacture and first processing of steel + steel tubes	271, 273, 2722, 2721, 275
102	Non- ferrous metals	274
103	Clay Products	264
104	Cement, lime and plaster	265
105	Articles of concrete, plaster and cement	266
106	Glass	261
107	Ceramics	262, 263
108	Chemical Products	241, 242, 246, 247
109	Paint & ink	243
110	Pharmaceuticals	244
111	Soap, detergents and toiletries	245
112	Casting, forging and first treatment of metal; manufacture of metal products	281, 282, 283, 286, 287
113	Manufacture of tractors and agricultural machinery	293
114	Manufacture of machine tools	294
115	Computer and office equipment	300
116	Insulated wires and cables	313
117	Manufacture of electrical machinery	311, 312
118	Batteries and accumulators	314, 316
119	Electronic valves, tubes and other components	321
120	Telecom; television and radio transmitters	322
121	Television and radio receivers, sound or video recording apparatus	323
122	Measuring, checking, testing instruments	332,333
123	Domestic electric appliances	297
124	Lighting equipment and lamps	315
125	Motor vehicles	341, 342
126	Motor vehicles parts	343
127	Shipbuilding	351
128	Railway, locomotives and stock	352
129	Cycles and motor cycles	354
130	Aerospace	353
131	Medical instruments	331
132	Optical instruments	334

Annex 1: MSM Industry Classification and NACE Concordance (continued)

MSM sector	Industry	Nace Rev. 1.1 (2002)
133	Clocks and watches	335
134	Oils and fats	154
135	Meat products	151
136	Dairy products	1551
137	Fruit and vegetables	153
138	Fish products	152
139	Grain milling and manufacture of starch	156
140	Pasta	1585
141	Bread, pastry and biscuits	1581, 1582
142	Sugar	1583
143	Confectionery and ice cream	1584, 1552
144	Animal feed	157
145	Alcohol, spirits, wine and cider	159 (except 1596, 1598)
146	Beer	1596
147	Soft drinks and water	1598
148	Tobacco	16
149	Textiles	171, 172, 173, 175, 176, 177
150	Leather	191, 192
151	Footwear	193
152	Clothing	181, 182, 183, 174
153	Wood sawing	201
154	Wood boards and other wooden products	202, 203, 204
155	Furniture	361
156	Paper, pulp and articles of paper	211, 212
157	Publishing	221, 222
158	Rubber products and rubber tyres	251
159	Plastics	252
160	Musical instruments	363
161	Toys and sports goods	364,365
162	Services	
162,1	Telecommunication services	642
162,2	IT services	72
162,3	Retailing	521, 522
162,4	Business services	74

Annex 2: Concordance between MSM sectors and patent technology classes

MSM	Name MSM Industry	Smoch Class	Name Smoch Class	IPC Classes
101	Manufacture and first processing of steel + steel tubes	19.1	Basic Metals	1D;C22B;C22C;C25C; C25F;C30B;D07B;E04H;F27D;H01
102	Non- ferrous metals	19.2	Basic Metals	B21C;B22D;C22B;C22C;C22F;C25 C;C25F;C30B;D07B;E04H;
103	Clay Products	18.1	Non-Metallic Mineral Products	B24D;B28B;B28C;B32B;C04B
104	Cement, lime and plaster	18.1	Non-Metallic Mineral Products	B24D;B28B;B28C;B32B;C04B
105	Articles of concrete, plaster and cement	18.2	Non-Metallic Mineral Products	D;B32B
106	Glass	18.3	Non-Metallic Mineral Products	B24D;B32B;C03B;C03C
107	Ceramics	18.1	Non-Metallic Mineral Products	B24D;B28B;B28C;B32B;C04B
108	Chemical Products	10,11,15,16	Basic Chemicals; Pesticides; Other Chemicals; Man-made fibres	
109	Paint & ink	12	Paints, Varnishes	
110	Pharmaceuticals	13	Pharmaceuticals	
111	Soap, detergents and toiletries	14	Soaps, Detergents and Toilet Preparations	
112	Casting, forging + first treatment of metal; manufact. metal products	20	Fabricated Metal Products	
113	Manufacture of tractors and agricultural machinery	23	Agricultural and Forestry Machinery	
114	Manufacture of machine tools	24	Machine-Tools	
115	Computer and office equipment	28	Office Machinery and Computers	
116	Insulated wires and cables	30	Electrical Distribution, Control, Wire, Cable	
117	Manufacture of electrical machinery	29+30	Electrical Motors, Generators, Transformers;Electrical Distribution, Control, Wire, Cable	
118	Batteries and accumulators	31+33	Accumulators, Battery; Other Electrical Equipment	
119	Electronic valves, tubes and other components	34	Electronic Components	
120	Telecom; television and radio transmitters	35	Signal Transmission, Telecommunications	
121	Television and radio receivers, sound or video recording apparatus	36	Television and Radio Receivers, Audivisual Electronics	
122	Measuring, checking, testing instruments	38+39	Measuring Instruments; Industrial Process Control Equipment	
123	Domestic electric appliances	27	Domestic Appliances	
124	Lighting equipment and lamps	32	Lightening Equipment	
125	Motor vehicles	42.1	Motor Vehicles	B60D;B60P;B60S;B62D;E01H;F01 L;F02B;F02D;F02F
126	Motor vehicles parts	42.2	Motor Vehicles	B60B;B60G;B60H;B60J;B60K;B60 L;B60N;B60Q;B60R;B60T;F01L;F
127	Shipbuilding	43.1	Other Transport Equipment	3C;B63H;B63J
128	Railway, locomotives and stock	43.2	Other Transport Equipment	F03H;F02K;B60V;B60W;B60F;B6 1C;B61D;B61F;B61G;B61H;B61J;

Annex 2: Concordance between MSM sectors and patent technology classes (continued)

MSM	Name MSM Industry	Smoch Class	Name Smoch Class	IPC Classes
129	Cycles and motor cycles	43.3	Other Transport Equipment	F03H;F02K;B60V;B60W;F03H;F0 2K;B62C;B62H;B62J;B62K;
130	Aerospace	43.4	Other Transport Equipment	4D;B64F;B64G;F02C
131	Medical instruments	37	Medical Equipment	
132	Optical instruments	40	Optical Instruments	
133	Clocks and watches	41	Watches, Clocks	
134	Oils and fats	1.1	Food, Beverages	A23D
135	Meat products	1.2	Food, Beverages	A23B
136	Dairy products	1.3	Food, Beverages	A23C
137	Fruit and vegetables	1.2	Food, Beverages	A23B
138	Fish products	1.2	Food, Beverages	A23B
139	Grain milling and manufacture of starch	1.4	Food, Beverages	A21D
140	Pasta	1.4	Food, Beverages	A21D
141	Bread, pastry and biscuits	1.4	Food, Beverages	A21D
142	Sugar	1.5	Food, Beverages	C13F;C13J;C13K
143	Confectionery and ice cream	1.6	Food, Beverages	A23G
144	Animal feed	1.7	Food, Beverages	A23K
145	Alcohol, spirits, wine and cider	1.8	Food, Beverages	C12F;C12G;C12H
146	Beer	1.9	Food, Beverages	C12C
147	Soft drinks and water	1.10	Food, Beverages	A23L
148	Tobacco	2	Tobacco Products	
149	Textiles	3	Textiles	
150	Leather	5.1	Leather Articles	B68B;B68C
151	Footwear	5.2	Leather Articles	A43B;A43C
152	Clothing	4	Wearing Apparel	
153	Wood sawing	6	Wood Products	
154	Wood boards and other wooden products	6	Wood Products	
155	Furniture	44.1	Furniture, Consumer Goods	A47B;A47C;A47D;A47F
156	Paper, pulp and articles of paper	7	Paper	
157	Publishing	8	Publishing, Printing	
158	Rubber products and rubber tyres	17.1	Rubber and Plastics Products	B60C
159	Plastics	17.2	Rubber and Plastics Products	5D;B67D;E02B;F16L;H02G
160	Musical instruments	44.2	Furniture, Consumer Goods	0H
161	Toys and sports goods	44.3	Furniture, Consumer Goods	A41G;A42B;A44C;A45B;A45F;A4 6B;A46D;A63B;A63C;A63DA63F; A63G;A63H;A63J;A63K;B43K;B4

Annex 3: Concentration and offshoring ratios per MSM sector

MSM code	MSM sector	C5	Offshoring ratio
101	steel and steel tubes	0,22	0,98
102	Non- ferrous metals	0,13	1,00
103	Clay Products	0,61	1,15
104	Cement, lime and plaster	0,56	0,98
105	Articles of concrete, plaster and cement	0,15	1,19
106	Glass	0,39	1,18
107	Ceramics	0,22	1,00
108	Chemical Products	0,16	1,04
109	Paint & ink	0,44	0,95
110	Pharmaceuticals	0,51	1,46
111	Soap, detergents and toiletries	0,80	1,19
112	manufacture of metal products	0,08	0,98
113	Manufacture of tractors and agricultural machinery	0,49	0,91
114	Manufacture of machine tools	0,18	0,96
115	Computer and office equipment	0,44	0,73
116	Insulated wires and cables	0,54	1,27
117	Manufacture of electrical machinery	0,24	0,98
118	Batteries and accumulators	0,07	1,13
119	Electronic valves, tubes and other components	0,23	1,28
120	Telecom; television and radio transmitters	0,88	1,01
121	Television, radio, sound or video recorders	0,35	0,65
122	Measuring, checking, testing instruments	0,28	1,18
123	Domestic electric appliances	0,44	1,01
124	Lighting equipment and lamps	0,56	1,31
125	Motor vehicles	0,53	0,99
126	Motor vehicles parts	0,26	0,85
127	Shipbuilding	0,41	1,17
128	Railway, locomotives and stock	0,50	1,61
129	Cycles and motor cycles	0,41	0,92
130	Aerospace	0,83	1,41
131	Medical instruments	0,44	1,25
132	Optical instruments	0,17	0,79
133	Clocks and watches	0,68	0,79
134	Oils and fats	0,44	1,14
135	Meat products	0,09	1,09
136	Dairy products	0,24	1,06
137	Fruit and vegetables	0,08	1,00
138	Fish products	0,34	0,87
139	Grain milling and manufacture of starch	0,17	1,27
140	Pasta	0,25	0,74
141	Bread, pastry and biscuits	0,13	1,33
142	Sugar	0,61	1,23
143	Confectionery and ice cream	0,29	1,05
144	Animal feed	0,13	1,33
145	Alcohol, spirits, wine and cider	0,23	1,83
146	Beer	0,53	0,76
147	Soft drinks and water	0,36	1,34
148	Tobacco	1,72	1,20
149	Textiles	0,03	1,46
150	Leather	0,49	3,09
151	Footwear	0,08	1,79
152	Clothing	0,46	1,07
153	Wood sawing	0,31	1,37
154	Wood boards and other wooden products	0,11	3,58
155	Furniture	0,04	0,80
156	Paper, pulp and articles of paper	0,23	1,05
157	Publishing	0,07	1,02
158	Rubber products and rubber tyres	0,50	0,95
159	Plastics	0,13	1,01
160	Musical instruments	0,59	0,85
161	Toys and sports goods	0,33	1,41
	All sectors (total matrix coverage)	*0,28*	

Notes: C5 is production share of top 5 leaders, Outsourcing is leaders' ratio of EU sales to EU production

Annex 4: Key Statistics of technology positions per sector

MSM sector	Share Patents In EU	Technology Fields 2007	Average Technological Diversification 2007	Firm average share of sectoral patents, 2007	Firm average share of sectoral patents, 2000
101	0,78	11	6,68	0,51	0,59
102	0,81	8	5,18	0,16	0,04
103	0,72	4	2,30	0,08	0,03
104	0,82	4	2,42	0,27	0,17
105	0,78	8	3,60	0,38	0,58
106	0,43	17	6,94	2,00	1,68
107	0,93	6	4,78	0,43	0,46
108	0,67	24	6,43	3,35	2,96
109	0,60	17	5,52	5,03	1,38
110	0,54	16	2,81	2,06	2,03
111	0,74	21	4,29	9,74	10,39
112	0,64	11	6,23	0,11	0,13
113	0,82	9	2,84	2,33	1,24
114	0,76	14	4,92	1,03	0,73
115	0,10	18	4,69	0,32	0,46
116	0,37	17	4,67	0,11	0,34
117	0,58	18	4,54	3,25	3,41
118	0,71	10	2,96	0,27	0,16
119	0,88	11	4,24	3,32	4,55
120	0,63	19	3,05	8,38	8,44
121	0,48	23	5,13	6,19	6,23
122	0,76	22	6,34	1,45	1,14
123	0,83	21	3,52	4,35	3,14
124	0,70	23	6,34	4,57	2,71
125	0,95	17	4,11	2,13	2,73
126	0,79	17	3,76	1,96	1,87
127	0,87	12	5,65	0,92	0,19
128	0,79	15	6,07	2,87	4,12
129	0,65	9	3,26	0,53	0,06
130	0,88	21	6,23	9,51	4,06
131	0,58	22	7,51	1,05	0,84
132	0,23	17	3,42	1,47	1,14
133	0,33	5	2,11	3,19	0,83
134	0,36	12	4,57	6,95	6,89
135	0,67	1	2,00	0,00	0,00
136	0,87	7	2,35	3,67	1,48
137	0,56	2	1,89	0,19	0,34
138	1,00	1	4,70	0,00	0,17
139	0,32	10	5,06	0,46	0,00
140	1,00	6	3,17	0,95	0,20
141	0,61	7	2,84	1,49	0,20
142	0,60	6	3,68	4,07	5,66
143	0,71	13	4,05	3,40	2,62
144	0,32	14	4,10	0,21	0,10
145	0,50	1	2,38	0,55	0,22
146	0,65	7	2,62	1,99	1,67
147	0,46	10	3,46	0,46	0,11

MSM sector	Share Patents In EU	Technology Fields 2007	Average Technological Diversification 2007	Firm average share of sectoral patents, 2007	Firm average share of sectoral patents, 2000
148	0,56	9	3,34	2,09	6,05
149	0,80	7	5,74	0,30	0,25
150	0,92	2	1,60	0,00	0,00
151	1,00	0	1,00	0,00	0,00
152	1,00	0	1,00	0,00	0,00
153	0,99	6	4,59	0,00	0,00
154	0,86	7	4,19	0,42	0,31
155	1,00	2	4,74	0,03	0,01
156	0,98	9	3,73	0,81	0,80
157	0,24	2	1,95	0,00	0,00
158	0,52	20	4,62	12,49	12,50
159	0,63	18	3,86	0,16	0,19
160	0,01	4	2,92	0,67	0,65
161	0,57	2	1,53	0,12	0,44

Annex 5: Classification of Sectors: Sutton typology of differentiated versus homogenous industries and Single Market Sensitive Industries

The study of Buigues, Ilzkovitz and Lebrun (1990) identified 40 out of the 120 manufacturing sectors at the NACE three digit level of disaggregation as be especially affected by the Single market Program (SMP). The sensitive sectors included those industries in which the main purchaser is the public sector, those where EU trade was hampered by differences in national standards and a variety of industries with administrative and/or technical controls impeding trade. The set of 40 sensitive industries listed in the report as '***SMP sensitive***' sectors or '***SMP***' sectors, correspond to the set of sectors listed in the table below. In the report, this will be referred to. The SMP sensitive industries where **public procurement** is important are indicated in bold.

106	Glass
107	Ceramics
108	Chemical Products
110	**Pharmaceuticals**
113	Manufacture of tractors and agricultural machinery
114	Manufacture of machine tools
115	**Computer and office equipment**
116	Insulated wires and cables
117	Manufacture of electrical machinery
119	Electronic valves, tubes and other components
120	**Telecom; television and radio transmitters**
121	Television and radio receivers, sound or video recording apparatus
122	Measuring, checking, testing instruments
123	Domestic electric appliances
124	Lighting equipment and lamps
125	Motor vehicles
127	Shipbuilding
128	**Railway, locomotives and stock**
130	Aerospace
131	**Medical instruments**
140	Pasta
144	Animal feed
146	Beer
147	Soft drinks and water
149	Textiles
150	Leather
151	Footwear
152	Clothing

The operational distinction between industries with and without differentiation (Sutton typology) was originally described in Davies and Lyons (1996, p. 28) on the basis of the following criteria: A **Type 1 industry** is one in which firms engage in neither type of competition: firms produce homogenous goods and no or little product differentiation takes place. A **Type 2 industry** is one in which typically firms engage in advertising and/or R&D rivalry. Roughly speaking, this means industries that have an advertising to sales ratio and/or R&D sales ratio in excess of 1%. When differentiation mainly takes place through R&D, industries are listed as **R&D intensive industries**.

MSM sector	Type of industry: 1= type1, 2=type 2 R&D =R&D intensive
101	1
102	1
103	1
104	1
105	1
106	1
107	1
108	R&D
109	R&D
110	R&D
111	R&D
112	1
113	R&D
114	R&D
115	R&D
116	R&D
117	R&D
118	R&D
119	R&D
120	R&D
121	R&D
122	R&D
123	R&D
124	R&D
125	R&D
126	R&D
127	1
128	R&D
129	R&D
130	R&D
131	R&D
132	R&D
133	R&D
134	2
135	1
136	2
137	2
138	1
139	1
140	1
141	1
142	1
143	2
144	2
145	2
146	2
147	2
148	2
149	1
150	1
151	1
152	1
153	1
154	1
155	1
156	1
157	1
158	R&D
159	1
160	2
161	2